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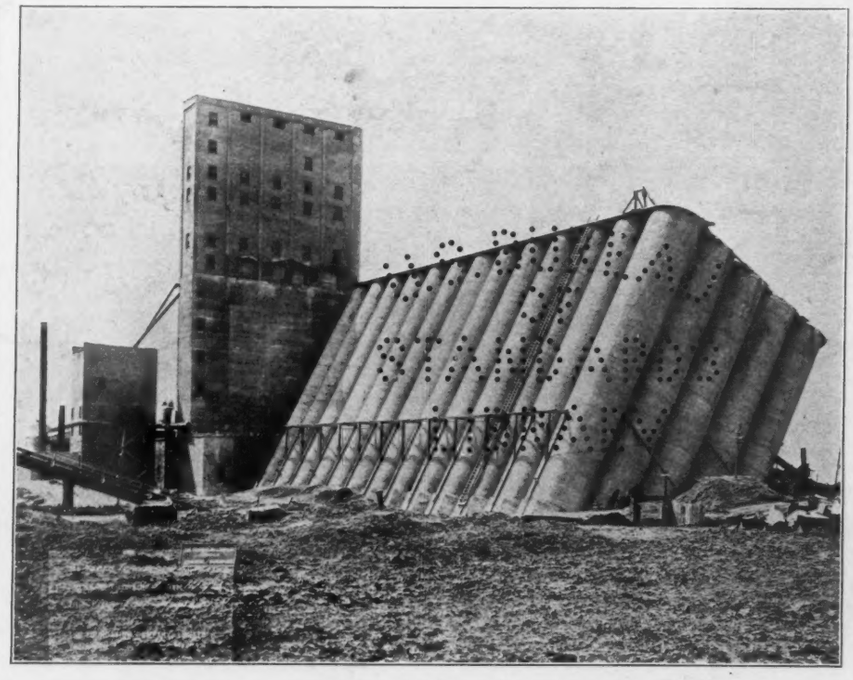

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APRIL, 1923

VOL. IV MASSACHUSETTS INSTITUTE OF TECHNOLOGY NO.1

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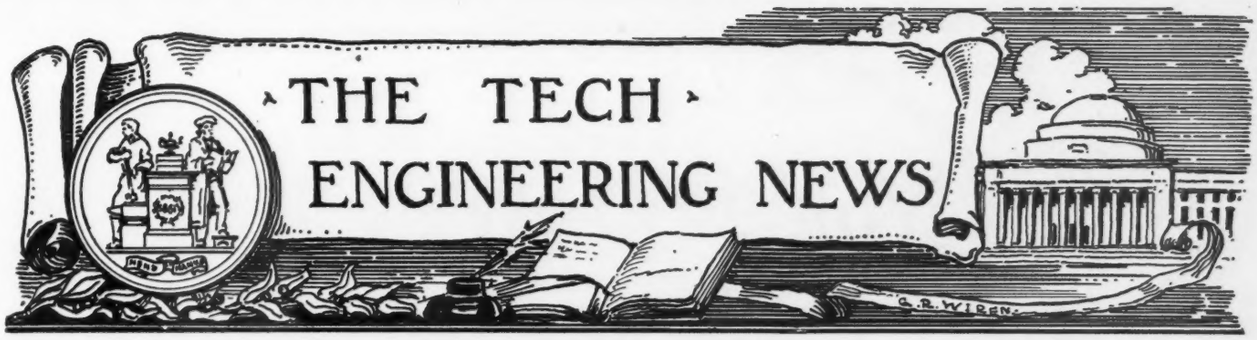

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To You Who Will Be Automotive Engineers—

You will be entering an industry so far-reaching that the sun never sets on its activities, an industry which in two short decades has become the second largest of the nation—yet, one which is but in its infancy.

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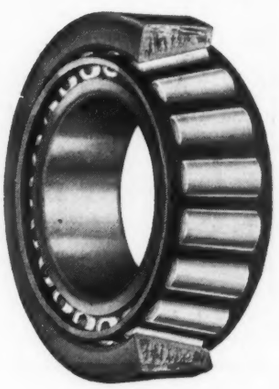

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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE ALUMNI AND UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME IV APRIL, 1923 NUMBER 1

APPLICATIONS OF THE EIGHT WHEEL CHASSIS TO MOTOR TRANSPORTATION

The destruction of highway pavements by heavy motor-drawn loads is the subject of most serious consideration among highway engineers today. Trucks have been increasing in size and the loads, essentially concentrated, have been becoming correspondingly greater with the result that engineers have built thicker and stronger pavements. Immediately the truck manufacturers increased the size of their trucks. In order to put some limit to this vicious circle all states now have a law limiting the load per inch of width of tire causing truck manufacturers to make excessively wide wheels.

Motor bus transportation has definitely demonstrated that it has a logical position in our transportation system. The reasons for this are briefly as follows:

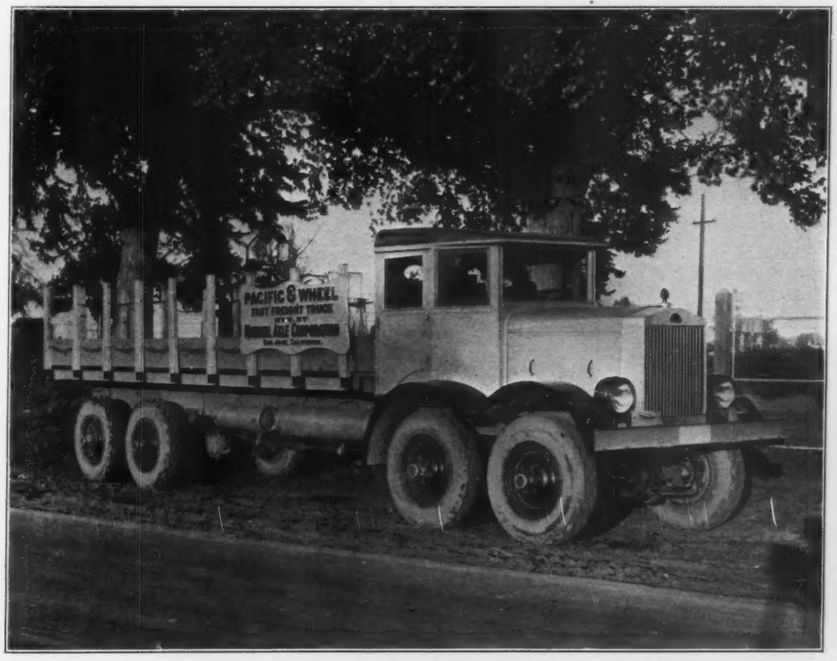
(1) A motor vehicle can go in any desired direction, requiring no tracks or overhead wires. (2) It possesses great flexibility, as it is able to drive around any ordinary obstruction. (3) It can pick up and discharge passengers at the curb. (4) The capitalized cost is less.

These conditions have been recognized and numerous successful bus companies have been organized, most notable among which are the Fifth Avenue Coach Company of New York City and the Peninsula Rapid Transit Company of San Francisco. However, there have been no regular busses built which they could utilize. They have had to be content with a truck chassis on which bus bodies were built. These were generally relatively slow and naturally did not give much consideration to the passengers' comfort. In the last year or two several companies have put out what is called a special bus chassis. The general characteristics are still those of a four-wheel truck. The jolt and vibration are excessive and the blowing out of large high pressure tires is a constant danger. Such a vehicle equipped with large pneumatic tires, and traveling thirty miles an hour, has very little chance of staying on the road if a front tire blows out.

It was in answer to these two problems, viz.: excessive tire loads, and comfort of passengers in busses, that led to the development of the eight-wheel chassis. The advantages of the eight-wheel principle of motor car construction have been proven by actual operation of a full-sized bus, which was built a year ago, and has been driven over California highways and mountain roads for over 13,000 miles. The first 2,500 miles of road testing developed what few minor changes were needed in design and construction. The completed stage was operated under regular working conditions, in all kinds of weather and gave complete satisfaction.

The chassis are built with four front steering wheels, and four rear driving wheels, designed so as to give flexibility in both the front and rear sets of wheels. The load is thus distributed over eight wheels, each wheel carrying half as much load as would be the case if there were only the usual four. Indeed this difference is even greater, from the fact that special attention was given to designing the eight-wheel trucks so that the center of gravity of the load is much farther forward than on the ordinary four-wheeler. In the latter the two rear wheels usually carry about 85 per cent of the total load,

(*Continued on page 30*)



PACIFIC EIGHT WHEEL TRUCK

The chassis is designed to give uniform distribution of load and maximum flexibility to the driving assembly.

LABORATORIES OF CHEMISTRY AND CHEMICAL ENGINEERING OF THE INSTITUTE

By PROF. HENRY P. TALBOT, '85
Dean of Students, Massachusetts Institute of Technology

It is a far cry from the few simple pieces of apparatus on tables in an upper room of a building on Summer Street, Boston, which constituted the physical and chemical equipment at the opening of the work of the Institute, to the extensive laboratories of the present plant, and the contrast affords striking evidence of the advances in chemical and physical science and in methods of instruction since 1865. The first chemical laboratories with anything like an adequate equipment were located in the basement of the Rogers Building on Boylston Street, Boston. These were transferred to the Walker Building in 1883 and were supplemented by laboratories of Industrial Chemistry in one of the buildings on Trinity Place in 1898, and those of Physical Chemistry in 1903. These laboratories, of which the present ones are lineal descendants, have an honorable history. In some of them, for example, was developed the first plan for laboratory instruction in chemistry and physics to larger groups of students; in others was begun the epoch-making work of William Ripley Nichols in the chemistry of sanitation, from which later resulted the classical development of the plan for the systematic and periodical examination of all the public water supplies in Massachusetts now conducted by the State. The Research Laboratory of Physical Chemistry, which has contributed so much to chemical science, had its beginning in some of the laboratories located on Trinity Place, and in others was begun the research work in Industrial Chemistry which has found its consummation in the present Research Laboratory of Applied Chemistry. These are but a few of the notable attainments of the past.

At present all laboratory instruction is accompanied by, or is coördinated with, classroom instruction of the lecture or quiz types. Graduate students also attend and participate in seminars conducted in the respective Divisions of the Departments.

The laboratories of Chemistry occupy portions of four of the sections of the present Institute building. Those of the Inorganic Division are located on the first and second floors, and are devoted to the instruction of first year students. The laboratory course is now based upon an entrance requirement in Chemistry and includes qualitative and quantitative experimentation, and the preparation of inorganic compounds. A maximum of eight hundred students has been accommodated in these laboratories. The equipment is relatively simple, being mostly desk apparatus, but a sufficient supply of electrical apparatus, furnaces, balances, etc., is provided to enable entire sections of the class to carry on parallel experiments simultaneously. The private laboratories of the staff are equipped for investigation work, the character of which varies with the special interests of the respective instructors.

The laboratories of the Division of Analytical Chemistry accommodate two hundred and sixty students and are planned to enable each student to have at his command at all times throughout the duration of the subject a full working equipment. Each desk is provided with a down-draft hood to remove fumes. In this laboratory, again, the equipment consists mainly of portable apparatus in the desks, but there are also provided steam tables, water baths, drying closets, and electrical heating devices; and balance rooms, with a total of about fifty balances, adjoin the main laboratories. A research laboratory accommodating twelve students also adjoins the main instructional laboratories, and a special room for combustions, with electrically heated furnaces, and a room for electrolytic determinations, with direct current and storage battery connections are in close proximity. The private laboratories are also equipped for research work. A notable investigation recently completed is that of a study of nitrogen in steels.

The laboratories of the Division of Organic Chemistry have already been enlarged twice since their transfer to the present building. They can accommodate about two hundred undergraduate students and about forty graduates, working for advanced degrees. Beside the complement of portable desk apparatus, steam and electrical appliances for heating, distillation and electrolysis are provided and other permanent equipment, such as a high-vacuum system, facilities for accurate study of electrical conductivities, thermostats, and centrifuges, are available for undergraduate or research work. The combustion room, which contains gas and electric furnaces, accommodates twenty students at one time. Graduate work in this Division has increased many fold in the past three years and has made necessary the fitting up of a number of small research laboratories. Among the notable types of investigation now in progress are (1) the study of the factors that determine the reactivity

THE TECHNOLOGY SERIES

Unfortunately, Tech men can never avail themselves of every advantage their Alma Mater has to offer and many alumni, who for a period, have been under her guidance have never seen the new plant and have no way of knowing their Alma Mater's increased sphere of activity. This year, THE TECH ENGINEERING NEWS is making a special effort to ameliorate this situation in presenting this series of articles on the new Technology, its business management, the work carried on in the laboratories, and the plans for the future. This series, of which this article and that on page 1½ are the seventh, has been prepared by men thoroughly familiar with the phases they treat upon and is as follows:

THE TECHNOLOGY BUILDINGS ..... October
F. J. Whiting, Editor, Stone & Webster Journal.

THE GROUNDS AND THEIR DEVELOPMENT ..... November
H. J. Carlson, President Alumni Association.

THE BUSINESS ADMINISTRATION OF THE INSTITUTE ..... December
H. S. Ford, Bursar.

THE POWER SYSTEM OF THE INSTITUTE ..... January
A. S. Smith, Superintendent of Buildings and Power.

THE ENGINEERING LABORATORIES ..... February
Prof. E. F. Miller, Head of Department of Mechanical Engineering.

THE MACHINE TOOL LABORATORIES ..... February
Prof. R. H. Smith, Assistant Professor in Machine Construction.

THE MINING, GEOLOGICAL, AND METALLURGICAL LABORATORIES ..... March
Prof. C. E. Locke, Associate Professor of Mining Engineering.

THE ELECTRICAL ENGINEERING LABORATORIES ..... March
Prof. F. A. Laws, Professor of Electrical Measurements.

THE CHEMICAL LABORATORIES ..... April
Prof. H. P. Talbot, Dean, Former Head of Department of Chemistry.

THE PHYSICAL LABORATORIES ..... April
Prof. C. L. Norton, Head of the Department of Physics.

RESEARCH AT THE INSTITUTE ..... May
Prof. H. M. Goodwin, Professor of Electrochemistry.

PLANS FOR THE FUTURE ..... June
To be announced.

of atoms or groups of atoms in organic compounds (a combination of organic and physical chemistry), (2) the study of the chemistry of the simple compounds in cracked and uncracked petroleums, (3) catalytic reduction of organic compounds by hydrogen, and (4) the systematic classification and identification of organic substances.

The Division of Physical Chemistry occupies an instructional laboratory which will accommodate over one hundred students working in sections and an investigational laboratory with fifteen working places. Both rooms are provided with furnaces, thermostats, electrolytic devices, and sets of special apparatus sufficient in quantity to enable sections to work simultaneously upon the same general program of experiments, if necessary. The laboratory instruction has been developed with great care and is in many respects unique. Particular attention is given to the study of electromotive forces associated with chemical changes, and to the development of the apparatus necessary for their accurate measurement.

In close proximity to the instructional laboratories are those of the Research Laboratory of Physical Chemistry. These are under a separate directorship and are devoted to graduate instruction and to investigations of an advanced nature, notably, at present, under three divisions: (1) The Electrolytic Solution Theory; (2) Equilibria and Heats of Solution; (3) Kinetic Theory Development. Other investigations of more immediate industrial significance, notably the study of helium and the properties of steam, are in progress under the charge of the Director and have already yielded results of much importance. This laboratory has its own machine shop and expert mechanician, and an extensive complement of the latest devices for exact physico-chemical measurements.

The laboratory of Technical Analysis is arranged for the examination and investigation of such materials as gases, oils, road building materials, rubber, paper, and other industrial products, and that of Water and Food Analysis for the complete study of food materials and the sanitary and industrial examination of water supplies.

The laboratory of Metallography now consists of a group of five rooms of which the first is a preparation room containing grinding and polishing machines of various types. The main laboratory is a large room equipped with special microscopes adapted to the examination of polished metal specimens and cabinets for housing the large collection of typical alloys. Three rooms are required for photographic work. The camera room is provided with the latest types of Bausch & Lomb and Leitz photomicrographic cameras and a smaller instrument for the macro study of metals. The other two rooms are a dark room of the usual type and a printing room provided with automatic printing and print-washing machines. In addition to instructional work, which is now given to nearly two hundred students including graduates and thesis men, the laboratory is concerned with four major problems, (1) the metallographic and physical properties of β-brass, (2) the production of Neumann bands in iron and steel, (3) the embrittlement of steel by hydrogen and the relations between structure and frictional properties of bearing metal.

Closely associated with the rooms devoted to Metallography is the Heat Treatment Laboratory (under the immediate control of the Department of Mechanical Engineering) equipped with many types of gas and electrically heated furnaces in which the heat treatment of metal can be carried out on a semi-commercial scale.

The laboratories of the Department of Chemical Engineering comprise an instructional laboratory of Chemical Engineering, a laboratory of Industrial Chemistry (temporarily located in a separate building) and a large group of laboratories assigned to the activities of the Research Laboratory of Applied Chemistry, which are closely interwoven with undergraduate and graduate instruction. The laboratory of Chemical Engineering contains typical industrial units such as a Maclaurin gas scrubber, two-effect Swenson evaporator, Kelly leaf filter press, Shriver plate and frame filter press, motor-generator set, electric resistance furnace, muffle furnace, Abbe mixer, two distilling columns, centrifugals, crushing and grinding equipment, and a coke-packed scrubbing tower. The laboratory of Industrial Chemistry is fully outfitted for the carrying on of semi-industrial operations which form the background for a thorough study of these processes in class-room and conference with respect to such factors as the cost of materials, and of time and energy consumed, and the design of an operating plant. These laboratories now accommodate about one hundred and twenty undergraduate and fifty graduate students. The system of instruction has been exceptionally well developed and is unique in that it interweaves chemistry and engineering into chemical engineering as a tangible entity.

The School of Chemical Engineering Practice maintains laboratories at the plants of the Bethlehem Steel Company at Buffalo, N. Y., the Eastern Manufacturing Company, at Bangor, Maine, the Merrimac Chemical Company at South Wilmington, Mass., and the Revere Sugar Refinery at Boston. Indeed, it may be said that a considerable portion of these plants are also included in the instructional facilities, since, under the direction of members of the Institute Faculty they are available for exhaustive tests of technical units operating on an industrial

(Continued on page 38)

Courtesy of the Technology Review

VIEW OF LABORATORY OF ORGANIC CHEMISTRY

THE FIXATION OF NITROGEN IN FRANCE

By PROF. JEAN CAVALIER
President of the University of Toulouse, France

Before the war, we obtained practically all our nitric acid from sodium nitrate imported from the Chile deposits.

We had important quantities of this substance as fertilizer, and the supply was able to continue regularly enough without other difficulties than those of transportation and of storage of large quantities of hygroscopic material.

Meanwhile, we could not lose sight of the question of synthetic nitric acid. The problem of nitrogen (the industrial preparation of compounds using atmospheric nitrogen as a starting point) had been agitated for a long time in preparation against the exhaustion of the deposits of Chile. In 1914, this problem had been solved practically by three procedures:

1. The direct combination of nitrogen and oxygen in the electric arc, a process which consumes large quantities of electric energy, and did not appear advantageous except in countries where this energy is abundant and cheap. Such is the case in Norway; large factories there make nitrates and nitrites; they delivered to us ammonium nitrate which was used in certain classes of war explosives.

2. The Cyanamide Process which consists of several successive operations:

(*a*) Manufacture of calcium carbide in the electric furnace.

(*b*) Manufacture of cyanamide by the reaction between the carbide and nitrogen.

(*c*) Manufacture of ammonia by the hydrolysis of the cyanamide.

(*d*) Finally, catalytic oxidation of ammonia by air and condensation of the products.

This process, which for the same weight of nitrogen consumes about three times less electrical energy than the preceding, was installed in Belgium a little before the war.

3. Haber Process, the combination in the presence of a catalyst, of nitrogen and hydrogen, yielding ammonia directly, which is then oxidized to obtain nitric acid.

It is by this process that Germany, who was not able any longer to receive sodium nitrate from Chile, prepared, during the war, the nitric acid which is indispensable for explosives, and was thus able to hold out for four years.

The situation was not at all the same for the Allies, who retained the freedom of the seas. Nevertheless, as a measure of precaution, in 1915 we installed in France two trial factories for making synthetic nitric acid, one by the electric arc and the other by the Cyanamide Process. The latter permitted numerous important researches on the different phases of the process, leading to simplifications in apparatus and improvement in yield. In 1917, when the intensity of the submarine war caused us to fear for the regularity of the arrivals from Norway and from Chile, a vast, complete plan was established for manufacturing synthetically with our own resources the combined nitrogen necessary for continuing the war.

This program included factories for calcium carbide, for nitrogen, and for cyanamide, and necessitated an electric power of 170,000 horse power which called especially for water power.

The program of works was decided upon in August, 1917. A year later, in August, 1918, three months before the armistice, it was sufficiently advanced to commence the production of synthetic acid. Now, only the plants for calcium carbide and cyanamide remain, the latter being useful in agriculture as a nitrogen fertilizer.

It is well known that the combination of nitrogen and hydrogen is an incomplete reaction; the presence of a catalyst accelerates the reaction without changing the equilibrium point. At 1000° C. and under a pressure of one atmosphere, when equilibrium is reached, the proportion combined is about 5/100,000 of the total mass.

The reaction proceeds with liberation of heat and contraction of volume (4 molecules, $N_2 + 3H_2$, giving 2 molecules NH_3). In accordance with the law of displacement of equilibrium (Le Chatelier's Principle), the proportion of ammonia increases when the temperature is lowered and when the pressure is increased.

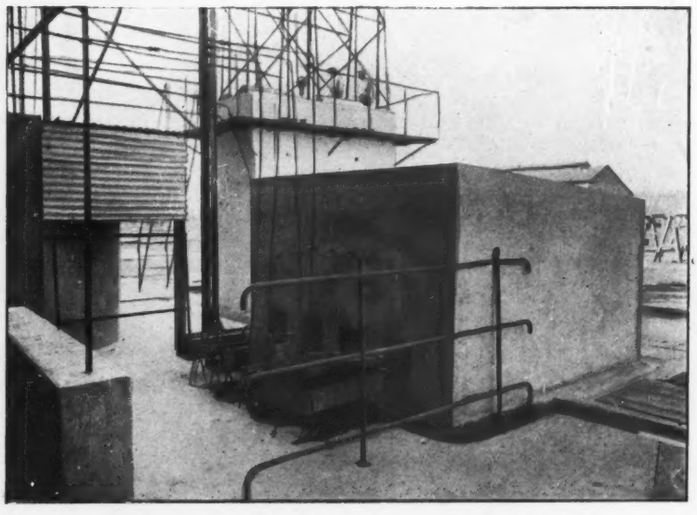
The speed of the reaction decreases rapidly when the temperature is lowered; it increases, on the other hand, with an increase in the pressure. In order that the operation may be used commercially, it is necessary to choose conditions of temperature and pressure which are practicable and which correspond to an equilibrium mixture sufficiently high and to a reaction sufficently rapid.

The Haber Process operates at a temperature of five to six hundred degrees, and at a pressure of one hundred and fifty to two hundred atmospheres. Under these conditions a yield of five to six per cent of ammonia is obtained, representing about one-half kilogram of the product per hour for every kilogram of catalyzer used. The gas, contained in a closed apparatus, circulates between the catalytic chamber and the cold region, where the ammonia condenses, by solution in water; the portion not combined returns to the catalyst.

Claude had the daring idea of operating at the high pressure of one thousand atmospheres, keeping the same temperature of about two hundred degrees. This makes the process much more rapid, yields of twenty-five per cent of ammonia being obtained, with a production of about five kilograms per hour and per one kilogram of catalyzer.

The walls of the container stay at room temperature, and it is not necessary to expend any heat to keep up the reaction. In the Haber Process, the same result is obtained by means of temperature changes

(*Continued on page 24*)



CATALIZING CHAMBER
This house contains four catalyzing tubes of a plant having a capacity of one and one quarter tons of ammonia per day.

ROGER WARD BABSON

By LEROY D. PEAVY, '98

Vice-President of Babson's Statistical Organization, Wellesley Hills, Mass.

Roger W. Babson was a member of the Class of 1898, the class which boasts of Lester Gardner, and the mascot beaver, and many other illustrious examples of Tech training. Strange to say, he did not of his own volition choose a career at M.I.T. His mind, like that of his father, who was a successful merchant, turned more to a business career than to science.

His father, however, with hard-headed sense, insisted that Roger should not loaf along at a cultural institution but should put in four years of solid study and hard work. Of course, the Institute was pre-eminently the place for such a training, and to the old Tech of Copley Square, and Walker, and Rogers, and Trinity Place he went, and gained some of his most valuable suggestions and a ground-work for his later career.

Roger Ward Babson was born in Gloucester, Massachusetts, in 1875. In those days Gloucester was a bustling fishing and manufacturing city of Cape Ann, its citizens resembling in their hardihood and vigor, the craggy promontory on which their city was located.

Roger, in such an environment, was reared in an atmosphere of hard work and hustle. Today there are but few men in the country his equal for dynamic energy. While other boys were playing, he was doing chores, and working a truck garden and selling his products from house to house. A business venture has always been of the keenest enjoyment to him. "I don't think I ever played a game of ball in my life," he said not long ago, and to this day the same traits are dominant in his makeup.

He has always wanted to be accomplishing something, even in his spare moments; in what ordinarily would be called a man's avocations. "The one great satisfaction in life," says he, "is to accomplish something." The only other outstanding thing of his boyhood days which seemed to interest his juvenile enthusiasm was a contest of some kind. Says he, "I always enjoyed a good scrap."

Be that as it may, Babson in 1894 found himself duly entered in Tech, where he was to struggle for four years with sines and cosines, amperes, reactions, stresses and strains. Why he chose Course I, I don't know, unless it was the first course on the list. But throughout his Institute career he was always more interested in the economic and industrial application of his studies than in the more technical and engineering phases of the work. He was particularly interested in Dr. Dewey's courses, with whom he has always kept in close touch, and was also captivated by the wonderful teaching ability and personality of Professor Swain, who was then head of Course I. They became, and still are, fast friends. Another characteristic of his student days was his great interest in social questions. Much of his spare time was spent in "settlement" work notably at the "South End House" in Boston.

ROGER WARD BABSON

Upon graduating in 1898 he turned immediately to the business and financial side of engineering prospects. There was an opportunity in a Boston banking house for a young man who could analyze statistics of railways and other companies. The manner in which he obtained his first job is characteristic of him. Seeing an advertisement in the paper, the only address being a post office box, he repaired early to the post office and watched the box number until somebody from the banking firm came and took out the mail. Following the man to the office, he applied in person and got the job!

For a year or two he continued to analyze operating statistics of corporations and to make personal investigations in various parts of the country on certain propositions — for the most part, public utilities. From this it was a natural step to street railway developments in the suburbs of Boston. This occupied his attention for a year or two, but he suddenly found that his exertions had brought upon him one of the worst of maladies, tuberculosis.

One lung was very seriously affected, and on the advice of the doctors he and his young wife started for the West. "As good as dead!" said his friends, and they never expected to see him again. He was told that if he was to live at all he must live in the open air. This meant that he could not go back to his old work. His physicians told him that he must not do anything active for a long while, and hard work in the open air almost inevitably means physical exertion. He was also told that he must not live in the East, yet the East was where his interests lay, and back to the East he was determined to go.

After thinking the matter over he concluded that there was as much fresh air in the East as in the West, and that if he were willing to endure the cold and vigorous climate and live in the open air, he would get well. After an investigation he found there were two places in Massachusetts which seemed most healthful. One of these was Wellesley Hills, and back to Wellesley he came. He moved into a little cottage, spending most of his time in bed, but with windows open or on a sleeping porch. He began to work his way back to health.

As he lay there his active brain continued to work. After thinking over various things that he might do, he decided, as he slowly improved, that he could act as a central bureau for certain statistical work along the line he had been working when he obtained his first job. The various banking houses were accustomed to make up descriptions of unlisted

(*Continued on page 26*)

RIGHTING A MILLION BUSHEL ELEVATOR

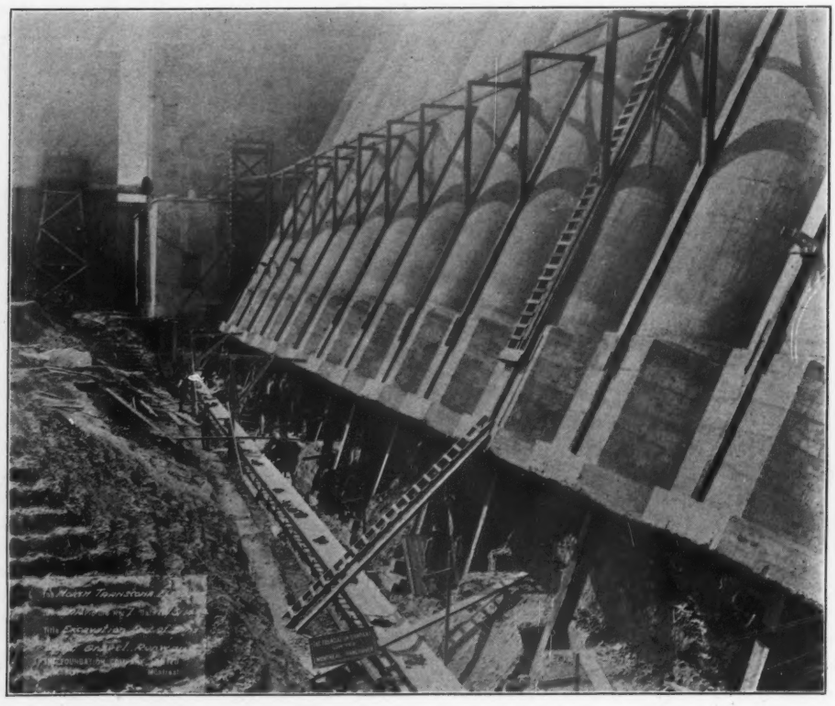
By FRANKLIN REMINGTON
Chairman of Board of The Foundation Company, New York City

There are few engineering undertakings that are more spectacular and appeal more to the imagination than the righting of the Transcona Elevator.

About ten years ago, the Canadian Pacific Railway, to facilitate the speedy shipment of grain from the Canadian Northwest, built a one-million-bushel grain elevator near Winnipeg. It was of reinforced concrete and consisted principally of a workhouse seventy feet by ninety-six feet and one hundred eighty feet high and a bin house seventy-seven feet by one hundred ninety-five feet and one hundred two feet high. The latter was made up of sixty-five circular bins fourteen feet four inches in diameter. These and the diamond-shaped spaces between afforded the storage capacity of approximately one million bushels. Both the workhouse and the bin house were equipped with the most modern conveying machinery for rapidly loading and unloading cars.

The whole structure — workhouse and bin house — rested on a floating foundation of reinforced concrete. The supporting mat for the workhouse was fifteen feet below the prairie level. For the bin house it was twelve feet below at which elevation the soil was found to be firm gray clay extending to a depth of about forty feet. In supporting the elevator on a floating foundation, the customary practice of that part of Canada was followed. Soil tests were made and it was found that the clay should safely carry a load of from three to four tons per square foot. The ultimate loading of the clay under the mat was calculated for this structure to be three and three-tenths tons per square foot. It was therefore assumed that, after a slight initial settlement, there would be no difficulty.

The Canadian Pacific Railway began storing grain in the Transcona Elevator in September, 1913. Care was taken to fill the bins so that the load would be uniformly distributed. On October 18, with 875,000 bushels in the bins, settlement was first noted and a vertical settling of one foot took place within an hour. Within twenty-four hours, the bins had leaned to the west twenty-seven degrees. The lower side was twenty-nine feet below its original position and the higher about five feet above its original position. Only the upheaval and compacting of the soil on the west side prevented the complete overturning of the structure, which in fact was found to be in a most hazardous position with its center of gravity dangerously near the lower edge.



RIGHTING THE ELEVATOR
Note the difficulty of sinking piers to rock under each of the twenty-four columns.

The railway engineers, confronted with an unprecedented problem, appealed to the leading firms specializing in engineering construction requesting that schemes and estimates for saving the grain elevator be presented without delay. The rivalry to produce a practicable plan was keen and finally the Canadian Pacific adopted the scheme of The Foundation Company as being not only the most practicable, but also the most novel. It included some features which might be characterized as daring but it also promised economy.

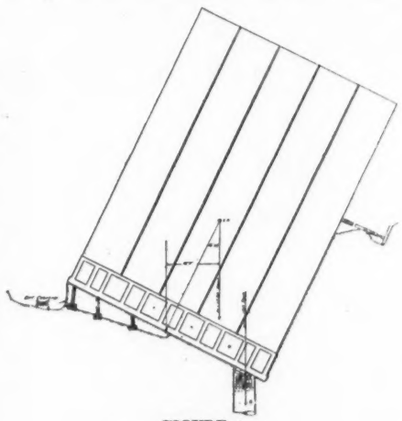


FIGURE 1
Plan to right the Bin House.

Among the first steps taken by the Canadian Pacific after the failure of the elevator was to get the grain out. This was done within three weeks by tapping the bins through the sides. Conveyors brought from Chicago assisted in the operation and when the contractor began work he found an empty structure weighing twenty thousand tons. Strangely the bin house was not materially damaged by the rough treatment it had received. This is one of the most striking evidences on record of the strength and practicability of reinforced concrete. The cover photo shows how the elevator looked in December, 1913, when the Foundation Company started work. An investigation of subsurface conditions showed that the clay which had been found to be stiff at the elevation of the reinforced concrete supporting mat, was very soft between elevation —30 and —40. The displacement of this soft stratum was apparently the cause of the failure. A line of boulders under the east side of the bin house explained the tipping to the west. Rock was found to be about fifty-five feet below the prairie level.

(*Continued on page 36*)

A TWENTY-FIVE MILE AN HOUR OFFICE BOY

By A. J. JOHNSON

Sales Engineer, The Standard Conveyor Company, North Street, St. Paul, Minn.

Who has ever heard of an office boy, cash boy or bell boy (or girl for that matter) travelling about an office, department store, hotel or plant at the rate of twenty-five miles an hour, carrying papers, messages and so forth upstairs, downstairs, here and there and back again, eight or nine hours of the day? You say it cannot be done and you are right, at least by the old type of office boy, who usually had to be bribed to move faster than a two-mile-an-hour walk.

There are, however, a few comparatively modern substitutes for these lads of ours, many of whom have been the object of curses in return for some story or practical joke originated with the boss as the subject, which probably have been the main factors in preventing the organization of a nation-wide "Union of Office Boys." These substitutes are in the forms of mechanical devices for the transportation of correspondence files and papers, documents, bank deposit books, order sheets, cash, small articles, packages, etc., in fact almost anything that can be carried in a small receptacle such as used in the various types of devices.

Probably the type of carrier system most commonly used in the average business establishments is the pneumatic tube. Pneumatic tubes are used to great advantage in practically every line of business as a connecting link between the various departments and permit the quick exchange of papers and cash. They are especially indispensable for the larger catalog houses, as will readily be understood from the following remarks regarding the system in use in the Montgomery-Ward buildings in St. Paul, Minn.

This installation makes it possible to follow a system of scheduling orders through the house which would otherwise be impossible and thereby enables the company to give its customers twenty-four to thirty-six hour service.

The incoming orders are received at the "mail-opening division" of the cashiers' department where the money enclosures are compared with the orders, the amount of the enclosures stamped or indicated on the orders and the money banked. The orders are then passed on to the "reading division" of the entry department where they are checked and the various items marked to facilitate the work of the "typing division" who prepare a separate sheet for each merchandise department represented by one or more items on the customer's order.

The "record division" then receives all the papers including the typed sheets and prepares for each new customer's order, or in other words the first order received from a customer, a stencil bearing the customer's name, address, railroad routing, and parcel post zone. This stencil is so made that it serves not only as a stencil but bears also spaces for recording the date, amount, etc., of the first as well as succeeding orders received from that particular customer. These stencils are used for addressing all merchandise, catalogs and advertising matter sent to the customers.

The orders are now ready for the scheduling and dispatching department, which separates the customer's order from the various typed sheets after having indicated on each the scheduled time for completion of the entire order. The customer's orders, together with folders and shipping instructions are sent direct to the shipping room and the typed copies of the orders to the central dispatching desk of the tube system.

All the separate sheets comprising each customer's order are scheduled for completion and arrival in the shipping room during some one twenty-minute interval, three or four hours from time of dispatching to the merchandise divisions. The dispatching is likewise done at twenty-minute intervals, the orders being permitted to accumulate in the interim, during which time the pneumatic tubes are released for other service. Usually up to one-half of the twenty minutes are required for dispatching the accumulated orders alone, so the system is uniformly busy throughout the entire working day.

The tube system itself is of the straight vacuum type, meaning that the carriers are propelled through the tubes by means of suction created by a compressor operated as an exhauster.

The tubes are four inches outside diameter and all curves are bent to a long radius, permitting the use of carriers having an inside diameter of two and three-quarter inches and an inside length of fourteen inches.

The power unit consists of a centrifugal compressor driven by a constant vacuum fifty horse-power motor giving a constant vacuum equivalent to a pressure of one and one-half pounds per square inch, with variable air volume ranging from full load down to half load, depending on the number of tubes in operation at a given time. The intake side of the compressor is connected with the tube system, thus creating suction or vacuum.

The terminals are of such construction and the tubes so arranged that

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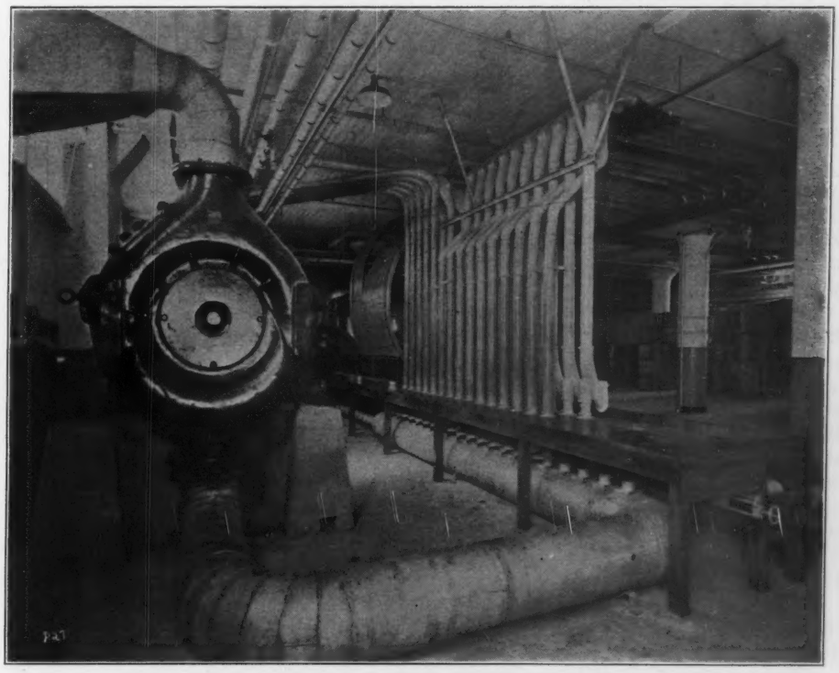

POWER UNIT

Fifty horsepower motor directly connected to the centrifugal compressor.

OPPORTUNITIES IN MARKETING FOR THE ENGINEER

By PROF. W. E. FREELAND
Assistant Professor of Economics, Massachusetts Institute of Technology

From the standpoint of both the economics of industry and the needs of society, the continued rise in the costs of domestic marketing challenges the interest of students of current business methods. The Joint Commission of Agricultural Inquiry determined by wide research that the marketing of farm products took forty-nine cents out of every sales dollar. It is generally accepted by marketing authorities that the sale of many specialty products, other than foodstuffs, takes from sixty to eighty cents of the sales dollar. Therefore the cost of marketing offers a point of attack vital to our social progress and industrial growth.

Elimination of wastes and reduction of costs will be attained by the men of engineering aptitude, even though they be not technically trained. Technical training, however, enables the man of engineering aptitude to utilize his talent more completely and, as a rule, much earlier in life, and thus increases his power to serve.

Engineers have done much for production. Our activities in exploiting and appropriating our natural resources have resulted in stressing production. Rapid growth in population and increasing export markets have made marketing a matter of comparative ease and there has been little occasion to investigate its wasteful methods or its lack of standards.

Just before the war some farsighted industrial leaders had begun to discern that the incomes of the future would come from productive effort rather than from exploitation and appropriation. They saw, too, that this would mean a great change in management policies and business methods; in a general tightening of control, in better methods of coördination, and in more scientific planning and scheduling.

The laboratory scientist and the manufacturing engineer had long been recognized as essential factors in the scheme of production, the industrial engineer had been accepted by the more progressive industries, and the management engineer was just finding himself tentatively accepted. The result of their work had put the American manufacturer in a position at least to hold his own against the lower wage schedules of other countries.

The engineer, then, had made a definite impress upon production. The impression that the engineer could fruitfully turn his attention to marketing — that the planning and scheduling of sales operations; the establishment of standards of performance; the setting up of methods of control; the research into markets, marketing methods, and merchandising factors of products; the formation of sales programs upon which production and financial programs were necessarily based; that these were engineering phases of marketing — this impression was beginning to grow upon industrial leaders. The impression, I repeat, was growing but activities in this direction were almost nil. Then the war came.

The war vastly increased our productive facilities. The pressure again was upon production. In many cases, the marketing organizations were reduced to skeletons for there was no surplus to market. The shelves of merchants became bare.

Two things of moment occurred after the war. One group, whose plants could be turned immediately to their former lines of production, found a hungry world awaiting them. Other industries, however, found themselves compelled to develop new products in order to utilize their expanded plant facilities. In the first case the marketing problem required no special consideration, merely the rebuilding of the old organization and a resumption of established methods of selling. In the second case, the engineering phases of marketing sprang into prominence at once; there was great need for research, analysis, planning and scheduling.

It was necessary to determine what products to make in order to utilize most profitably the plant, its equipment, and the labor supply available. In some cases, the equipment was not available for peace production. In most instances, the plant location, the character of labor available, and the potential competition were deciding factors.

It was necessary to determine the sales possibilities, for the size of the potential market formed the foundation for determining the allocation of floor space and the amount of equipment to be purchased. It was necessary, too, that the method of distribution be determined and the probable cost of selling be ascertained.

It was in the industrial establishments, that had to find new products and new markets, that the engineers were first installed as component parts of a marketing organization. There had been research divisions earlier but they were not charged with the formulation of plans nor the establishment of standards, schedules and methods of control. So far as the writer is aware, the first man to definitely set forth the necessity of distinguishing between the engineering and production phases of marketing was John E. Otterson, president of the Winchester-Simmons Company. Faced in late 1918 with the problem of filling the huge Winchester munitions plant with new types of production, he organized a "sales engineering" division early in 1919.

He believes that men in business divide themselves roughly into two classes — engineering and executive — and that you can expect to find the balanced combination of these two types only in those comparatively rare men who are destined to be general managers. He defines the engineer as analytical, studious, synthetical; having imagination, initiative, constructive powers; dealing with laws and abstract facts; and with the capacity to concentrate continuously on a single problem until it has been solved. He defines the executive (or operating) type as a man of action, boldness, ingenuity, force, determination, aggressiveness, courage, decision; one who rapidly assimilates facts and fills in what is lacking in the way of facts from his experience, judgment and intuition; one who can work with a multitude of constantly changing problems at one time.

He felt that the elements, which had led to the organization of separate units for engineering and operating in the field of production, also existed in the field of marketing and demanded a parallel organization. It was the writer's good fortune to discuss this conception on two occasions before the Taylor Society and to see the matter, contributed at that time, included in several books on business management and marketing which have since appeared. He has also had the privilege of helping other industries organize along similar lines.

Under the form of organization in which the sales department was concerned only with sales operation, it was common to find the sales manager in his eagerness to increase sales volume constantly urging changes in products to meet the demands of distributors for modification that would give individuality to their particular purchases. The engineer has fought steadily for standardization (or simplification) of products and his profit-making capacity in this direction has gained general recognition.

(*Continued on page 20*)

RECENT DEVELOPMENTS IN ALASKA

By MAJ. JOHN C. GOTWALS
Chief Engineer, Alaskan Road Commission

The stage of development reached in Alaska today and the character of that country are again of striking interest. This has been brought about by the recent completion of the Alaska Railroad from the all-year-round open waters of the Northwest to Fairbanks in an interior river valley.

As a study of the development of a pioneer country and as a means of speculating upon its future development, a brief review of the status of Alaska today, both as a producer of wealth and as a growing American settlement, is notable. The history of Alaska, after its purchase from the Russians in 1867, contained no notable feature until the placer developments of Nome, Fairbanks and other interior camps in the first decade of the Twentieth Century. Following the placer development, quartz mining was stimulated and the production of copper reached very substantial amounts, chiefly from one large mine in the Copper River Valley.

The development of Alaska was fairly rapid during this period (1910 to 1920). However, with the rising prices preceding and following our entrance in the World War, the production of gold was very seriously curtailed, due both to the mining population being attracted outside of the Territory and to the higher cost of supplies. At the present time, with the completion of the railroad and the dropping prices following the war, the interest of the United States has again been turned to this stupendous Territory.

The climate of the Territory, although fairly well known, is not nearly as severe or at least as trying, as is generally supposed. The coastal country, flanked by the very rugged coast range, and affected by the eastward trending Japanese Current, has a climate very similar to the coastal portion of the State of Washington, which is distinguished by heavy rainfall and no very great extremes of temperature. In the interior, within the Coast and Alaska Range, much greater ranges of temperature are met with and comparatively little rain or snow fall. The change of climate met with from the coastal country to the interior is quite parallel to that encountered in going from a coast city in the northwest portion of the United States to a point just east of the Rocky Mountains.

The topography of Alaska is excessively broken up, containing two especially high groups of mountains, that is, the Mt. St. Elias Range and the McKinley Range. Each range rises up in its highest peak to twenty thousand feet elevation. North of the Alaska Range the country drops into the much more gently rolling interior river valleys of the Kuskokwim and the Yukon with its tributaries. Even in this valley the country is of bold relief. North of the Yukon Valley the Endicott Range forms a divide from which the river systems flow into the Arctic Ocean. The Coast Range contains many vast glaciers. These great ice masses also occur on the south slope of the Alaska Range and a few are met with on the north slope of these mountains. In the interior river valleys in many places is encountered gravel frozen to bedrock. Such localities, due to surface thawing, become very annoying swamps during the warm summer of the interior.

In mining development, the chief industry of Alaska, following the buoyant development of the Alaska placer mines and the discouraging conditions suffered during the war period, mining is again taking on substantial development. While Alaska has been fairly well prospected for placer gold both the prospecting and development for quartz and base ores have been very backward. The production of the Kennecott Copper Mine, the only substantial effort made in quartz mining in the interior, is very encouraging as a token of the possibility of the interior for hardrock mining. With more development of hardrock mining, due to the longer life of such operations much more settled conditions can be expected in both population and trade. It is in respect to the further development of interior hardrock mining development that the Alaska Railroad will be of the greatest value.

The importance and production of Alaska fisheries are well known. They rank among the greatest in the world in the production of salmon, fresh halibut, herring and with lesser amount of shrimps, crabs and clams, and have poured wealth into the United States to the extent of nearly half a billion dollars in the period in which the country has been under American supervision.

The timber resources of Alaska, while of little interest as structural material except for local use, have high value for manufacturing into wood pulp. Little development has, so far, taken place along this line. However, the stand of spruce timber in the coastal country of Alaska is much greater and of much higher value than the casual observer from the deck of a coastwise steamship believes. Spruce, cottonwood, and birch timber are encountered over considerable areas in the interior but the stumpage is never high. The timber itself is low grade, chiefly valuable for fuel.

Reviewing the territory as a whole and reflecting upon the development of the most nearly similar portion of the United States, brings considerable encouragement to one in anticipating the complete settlement and development of Alaska. When one considers the early days in the development of California and the Northwest, the comparison is overwhelmingly that Alaska today has very much less harsh

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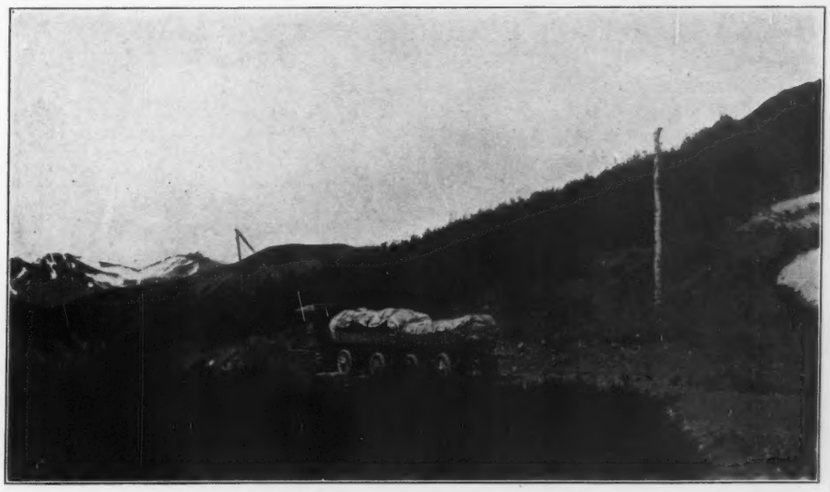


SUMMER FREIGHTING IN ALASKA

THE PHYSICAL LABORATORIES OF THE INSTITUTE

By PROF. CHARLES LADD NORTON, '93

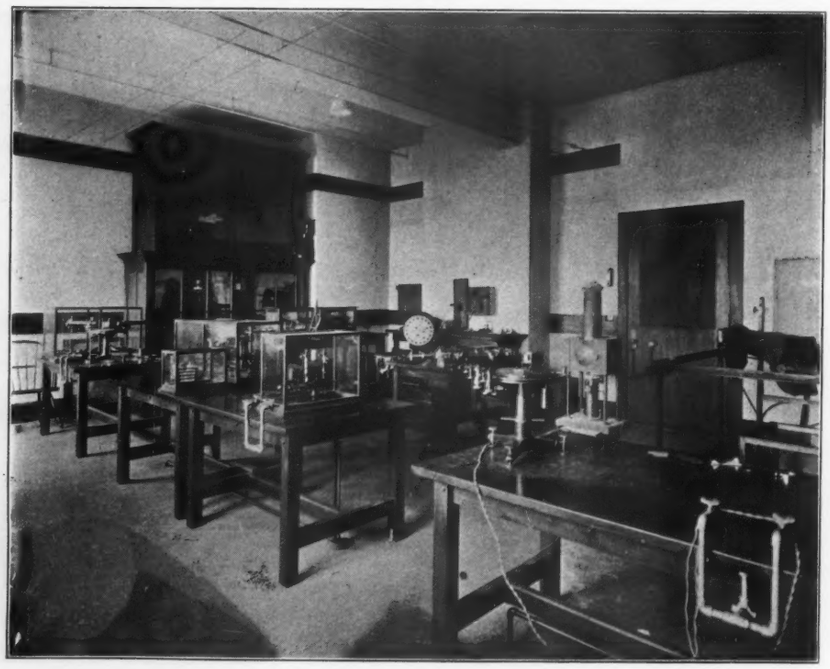
Head of Department of Physics, Massachusetts Institute of Technology

Technology stands perhaps more prominently than any other institution as an exponent of the laboratory method of teaching science, and it is but natural, therefore, that her present great equipment should comprise well-equipped laboratories for instruction in the fundamental sciences of physics and chemistry. Like all the rest of the Institute's laboratories, the physical laboratory came from a very humble beginning. A single room equipped with very meagre apparatus has gradually developed into a whole series of specialized laboratories devoted to the several branches of physics.

Soon after the founding of the Institute, the physical laboratories were quartered in the basement of the old Rogers Building on Boylston Street. When the Walker Building adjoining was built about 1885, the lower half was devoted to the laboratories and lecture rooms of the Department of Physics. It was here in the late eighties that the tremendous development of electrical engineering began as a part of the work in physics, and it was here that the first instruction was given in electrical engineering in the country, and one of the first, if not the pioneer, electrical engineering laboratory was started. Not long afterward, the work in electrical engineering having grown to large proportions, accomodations had to be provided for it in the new Lowell building erected on Trinity Place. When the Institute moved to Cambridge, the physical laboratories were provided for in that portion of the great group known as Building 4 on the east side of the main court.

The most important task of the Department of Physics is, of course, the teaching of fundamental physics to all of the students in the first and second year, and the elementary laboratories of mechanics, optics, heat, and electricity have been provided and equipped for this work. These laboratories, like all progressive laboratories, are in a constant state of change with the development of science and the improvement of teaching methods, but in general they are devoted to simple experiments, whose purpose is to train the student in methods of manipulation, to increase his power of observation, to enable him to acquire facility in making a satisfactory series of deductions from, and a suitable report upon, his own experiments. Incidentally, it is hoped that the laboratory equipment will enable the student to acquaint himself with some of the more interesting phenomena of elementary physics. For the work of the students of later years there are special laboratories, many of which are equipped with special apparatus developed in part or wholly at the Institute.

For work of the third and fourth year in electricity there are several laboratories equipped to carry on electrical measurements, and to enable students to familiarize themselves with electrical phenomena relating particularly to the field of electricity as a branch of pure science rather than as an elementary portion of electrical engineering. These laboratories are equipped with an electrical supply of considerable variety of voltages and frequency, and large amounts of measuring apparatus which serves both for instruction and research in modern electrical phenomena. Included in this general group of smaller electrical laboratories are those devoted to the study of X-ray phenomena and the electrical discharge in vacuo, and to the elementary electronic phenomena. The X-ray equipment includes several powerful static machines, a fifty-thousand volt Kenotron set, and numerous pumps and tubes. Extensive additions to the equipment of these laboratories are being made.



OPTICS LABORATORY

The laboratories devoted to the study of heat phenomena include the laboratory of heat measurements and the cryogenic laboratory. The laboratory of heat measurements, consisting of two large rooms on the first and second floors, is one of the best equipped in the country for the study of high temperatures or for the determinations of the variation in the physical properties of the materials over wide ranges of temperature. It is equipped with great numbers of gas and electric furnaces, and pyrometers, and much special apparatus for the measuring of coefficients of expansion and thermal conductivity. It has an excellent electrical supply controllable over a wide range. A most complete collection of apparatus for the determination of heats of combustion and a large array of apparatus for the economical use of gas in the industrial arts is also included in its equipment. From this laboratory has come out, in the past, a considerable amount of industrial development relating particularly to economy by means of the

saving of heat and a very material diminution of the annual loss of life and property through the development of work on fire prevention. For a long time a portion of the laboratory has been devoted to the study of refractories and recently a portion has been set aside as a nucleus for the ceramics laboratory to include the work in refractories and other clay products.

LABORATORY OF INDUSTRIAL PHYSICS

The low temperature work is carried on in laboratories in the basement in close connection with the laboratory of physical chemistry. The equipment consists of an excellent liquid air plant with cryostats and other accessory apparatus suitable for the maintenance of low temperature baths at controlled pressures sufficient to provide for most exacting research. In this laboratory extensive research in conjunction with the Bureau of Mines has been going on for several years. It is expected that the low temperature laboratory will be transferred in the next few months to the new building recently erected for it.

The work in optics is distributed over a number of comparatively small laboratories. The laboratory for optical measurements has excellent equipment for furnishing instruction in the ordinary simpler optical measurements and includes excellent modern apparatus for exacting research and instruction in photometry, spectrography, photo-microscopy and photo-electricity. Closely associated with it is the photographic laboratory with its dark rooms, photomteers, etc. Equipment is now being added for the photometric study of automobile headlights. The major portion of the optical equipment was made by Zeiss. A special development of the work in optics has lead to the equipment of a new laboratory of photo-elasticity. This laboratory is equipped with a Hilger optical set and a large number of special extensometers, dynamometers, and loading devices needed in this work.

The laboratory of acoustics has recently been moved, because of the crowded condition of the general physics laboratories into the basement of Building 2, where it has been provided with excellent quarters and with suitable new equipment, and is now adequately provided with apparatus for instruction and research in general and architectural acoustics.

The laboratories of electro-chemistry are situated on the first floor and in the basement, the upper room being provided with equipment for the study of the general principles and phenomena of electro-chemistry and the lower laboratories have an exceptionally complete equipment of transformers and furnaces for the study of the principles of applied electro-chemistry. It includes a motor generator which supplies large amounts of direct current suitable for experiments in electrolysis upon a large scale, several large transformers for furnance supply, and resistance and induction furnaces with the needful control apparatus.

Included with the physical laboratories are thel aboratories devoted to aeronautics comprising the wind tunnels and the aerodynamics laboratory. This equipment is by far the most complete for instruction and research in aeronautics of any equipment available for this sort of work in this country. There are two wind tunnels, one four feet in diameter, and the other seven feet, and a large amount of special apparatus for the study of aerodynamics and its application to the design of aeroplanes and airships.

Throughout this whole system of laboratories, since the development of the course of Industrial Physics, a course which it is believed originated at Technology, there has been set aside a portion of the space and equipment to form a working laboratory of industrial physics. A large portion of the basement of Building 2 has been equipped for this purpose, The equipment of this portion of our laboratories varies from time to time in accordance with the industrial problems under consideration, but it is being rapidly added to in large amounts through gifts of the industrial companies upon whose problems the students and instructors are working.

There are a large number of well equipped small research laboratories in which graduate students and members of the staff are carrying on research.

RECOMMENDED ARTICLES

"Seaplanes — Present Status of the Question," *Aviation*, March 12, 1923.

"Combustion Control of Steam Boilers," *Power*, March 6, 1923.

"Salt Water in Suspension," *Motorship*, March 6, 1923.

"Ventilation of Ships, with Special Consideration to Air Supply of Fire rooms," *Journal of the American Society of Naval Engineers*, February, 1923.

"Rivalry for United States Gliding Meet," *Aviation*, March 12, 1923.

"The Highways of Pennsylvania," *Engineers and Engineering*, January, 1923.

"Mean Effective Pressure of Internal Combustion Engines," *Power*, March 13, 1923.

"Helium in National Defense," *Aerial Age*, March, 1923.

"The Need of An American Merchant Marine," *Engineers and Engineering*, January, 1923.

"Rubber Production Possibilities in the Philippines," *Rubber Age*, February 25, 1923.

"The Naval Academy of Today and Its Mission," *United States Naval Institute Proceedings*, March, 1923.

"Analysis of Airplane Factors," *Journal of the Franklin Institute*, March, 1923.

MONTHLY NEWS

Measurement of Instantaneous Pressures. Quartz plates properly cut from quartz crystal liberate an electric charge when subjected to pressure. In order to measure the pressure developed in a gun during firing, a stack of these plates are placed in a small steel container in the form of a plug which is screwed into the breach block.

The charge which is liberated when the gun is fired passes through a special type of galvanometer and the galvanometer movements are photographed on a rapidly-moving film. By means of the trace on the film, it is possible to determine the pressure at any time during the explosion, also the rate of combustion of the powder, the velocity the projectile would have if there were no friction, etc.

The device can also be used for measuring the impact or "force of blow" struck by hammers, baseballs, boxing experts, rifle bullets, automobile bumpers, clock and watch escapements, etc.

This method of pressure measurement is described in Scientific Paper, No. 445, of the Bureau of Standards, which will soon be ready for distribution from the Superintendent of Documents, Government Printing Office, Washington, D.C., at five cents a copy.

Vast Terminal for Chicago. A new passenger terminal — ultimately electrified — which will cover fifty acres at cost $55,000,000 has been planned to replace the old Dearborn Street Terminal. The designers assert this will care for the seven roads now occupying the Dearborn Terminal but will permit addition of New York Central and Rock Island lines now housed elsewhere. Aside from the importance of an adequate and appropriate terminal, this plan will have three effects on growth and development of Chicago — the elimination of smoke and cinders through electrification; the opening up of all streets within that area; the building of apartment houses, hotels, and commercial structures now occupied by unsightly terminals, due to underground terminal space. This development is similar to the Grand Central Station development with Hotel Biltmore and Hotel Commodore on either side.

The Georgetown Bridge that was recently opened, is one of the largest concrete bridges ever built. It was built by the United States Army Engineers and is an important approach to Washington, D. C., and to Rosslyn, Va. It is also known as "Key's Highway Bridge, from the fact that the Georgetown approach is near the house once occupied by Francis Scott Key, the author of the "Star-Spangled Banner."

The bridge is built of reinforced concrete with a total length of 2,700 feet. The spans vary from 85 to 208 feet in length. The steel arches were assembled on scows and floated into place. An almost indispensable feature of the construction was a 1,700-foot cable, with a carrying capacity of five tons. This was a 1,700-foot Lidgerwood cableway used for the transportation of materials. The supporting towers for the cable were of wood construction, 145 feet high. The cableway was operated under steam power, and assisted greatly in the timely completion of the undertaking.

Sound Photography has taken a great step in advance with the invention of the Pallophotophone. This instrument, which records the human voice, music, and other sounds by photography, was demonstrated at a recent meeting of the American Institute of Electrical Engineers at the Engineering Society Building, 29 West 39th Street, New York City.

During the meeting, the record of a violin which was played, was reproduced on the Pallophotophone, showing with what distinctness the instrument was capable of reproducing the sounds of high pitch which most of these devises can only blur.

Automatic Control of Drill Tempering. We hear from South Africa that as a result of successive tests with drills, as regards their degree of resistance compared to their various methods of tempering, a new process has been devised by which the temperature of tempering is controlled automatically.

The drills are held in position by magnets when the steel reaches the critical temperature it loses its magnetism and is drawn out automatically by springs.

So far the work has been only of an experimental character, but nevertheless "perfect" tempering and "perfect" gauging of drill steels are objectives well worth considerable expenditures.

New Oil Field. The discovery of a new oil field at San Luis Potosi, Mexico, has caused a great deal of excitement among oil operators. Information has been received that a wildcat well which was drilled on the Tulillo Ranch, although more than a hundred miles from the nearest production, resulted in an oil flow of more than 1,400 barrels per day. It is stated that this flow may be greatly increased by drilling the well deeper.

Several of the larger American and other foreign oil companies have applied to the Government for permission to drill a number of wells on the holdings which they have been successful in obtaining in the new field.

The fact that this is the first discovery of oil in Mexico in a locality so far removed from the Gulf Coast makes it a find of extraordinary importance, it is declared.

The oil in the Tulillo well is said to be of a much higher grade than that in any of the Gulf Coast fields.

Permeable Rubber Sheets. The well-known impermeability of rubber to air and gases is remedied in cases where permeability is desired by incorporating with the plastic material a filler holding a liquid or gaseous pore-producing agent. The sheet that is made with the mixture is set in a pliable permeable condition. The sheet is preferably made or applied to a fabric background. For example, 100 parts of pale crepe rubber, 10 parts of zinc oxide, 4 parts of paratoluidine, 2 parts of sulphur, 4 parts of "dibutyldixanthic disulphide" are mixed together wth enough solvent naphtha to make a pasty mass. Then 100 parts of cotton fibre saturated with water are mixed with this composition. The mass is then calendered on to a fabric which has been previously thinly coated with rubber. The sheet may be embossed and varnished, and then is heated to expel the water and thus form pores. The vulcanization of the mixture takes place at a temperature of 200 degrees Fahrenheit. See British Patent No. 177,778.— *Rubber Age.*

The Illinois Memorial Stadium. George Huff, Director of Athletics at the University of Illinois, recently made known some interesting facts concerning the Illinois Memorial Stadium, which will be dedicated on November 3, 1923, the occasion of the annual home game with the University of Chicago. The statistics on the stadium follow:

Ultimate cost more than	$2,000,000
Already pledged	1,995,000
Stadium to cover	eight acres
Stadium field	56 acres
Capacity east and west stands	55,000
Capacity of north end	30,000
Total Capacity	120,000
Steel to be used	2,700 tons

Exterior to be red brick and Bedford stone, with 100 columns of stone 24 feet high on each stand forming two colonnades 424 feet long and 15 feet wide, erected in memory of Illini who gave their lives in the world war. There will also be a column for the Unknown soldier, and one for the honored dead of the other conference universities. Of the 55,000 seats in the east and west stands 40,000 will be within the limits of the goal posts. Beneath each stand will be a great hall 414 feet long by 50 feet wide, to be used for other sports, such as basketball, ice-skating rinks, and swimming. In the stadium proper there will be for track, two 220-yard straightaways and a quarter-mile track. Training quarters, showers, lockers, press boxes and an emergency hospital have all been provided for in the plans for the stadium.

Modification of Metric System According to a recent issue of the "Decimal Educator," the official organ of the Decimal Association, the association proposes to concentrate its efforts for the time being on securing an alteration of the value of the pound weight from 454 to 500 grams; that is half a kilogram. The ounce of 16 to the pound would in the first instance be retained so that four ounces would be 125 grams. The Newton would be 2,000 new pounds, equal to the metric ton and a little more than 15 per cent greater than the present ton. All denominations between the pound and ton, such as hundredweights, quarters, and stones of all kinds, would be eliminated and intermediate weights expressed in pounds.

Steam by Electricity. A practical apparatus which generates steam by electricity has been announced by the General Electric Company. Its operation is so sure and efficient as to insure its permanent future. The device is known as the "Electric Steam Generator" and does the same work that the ordinary steam boiler performs, but requires no engineers or firemen to look after its operation. It is said to be very economical in its fuel consumption.

It is composed of a cylindrical tank several feet high, the interior of which is divided into two compartments. These are termed, respectively, the hot well, below, and the electrode chamber above.

The water enters the hot well through a feed pipe and is forced into the electrode chamber by a motor-driven pump. In the electrode compartment are three large round iron electrodes which generate the steam. These electrodes are submerged during normal operation. A continual circulation of the heated water facilitates the rapid raising of steam if the pressure is lowered because of increased demand.

Rubber Paving Block. A strip of rubber roadway in Southwark, England, was recently relaid with a new type of rubber paving block, developed as a result of much experimentation by Rubber Roadways, Ltd., and manufactured by the Leyland and Birmingham Rubber Company, Ltd. The blocks, which weigh four pounds nine ounces each, are of the same size as the standard wood paving blocks, and are laid on the kind of foundation with equal ease and rapidity. They are of solid rubber, but the wearing surface is, of course, of a higher quality than the base. An application of pitch to the sides of the blocks, which are grooved, and to the end is made while they are being laid. — *Rubber Age.*

$100,000 Air Line. Among the new corporations which have recently received charters through the Secretary of State, is the Ta-Miami Air Line of Miami. This Corporation is capitalized for $100,000 and intends to establish a line for airplane transportation between Miami and Tampa, and between Miami and other Florida points. The Corporation has announced that operation is to begin along this route immediately.

Ancient Quarries have been discovered in Rhodesia about four miles from Rusape, on the Salisbury-Beira Railway line. The quarries consist of ancient workings of granite and dolorite. There are also indications which show that a huge amount of quartz was removed by some ancient race. Assays of samples which have been removed show small quantities of gold, but there is no other mineral present of any commercial value.

The discoverer of the workings has staked off holdings and is leading investigations to determine the importance of his find. It will be interesting to ascertain what the extent of the gold will be, as it is said that there are numerous workings of a similar nature between this location and Wedze, farther to the south.

No indication of smelting by the natives has been found although stone hammers have been found in the quarries. These excavations have been proved to a depth of fifty feet but the bottom has not been reached. It is possible that the ore was washed by the natives in the Rusape river, about half a mile from the quarries.

It is planned to undertake vigorous work in developing the region as soon as possible.

New Airplane Field for Boston. Recently Mayor Curley of Boston, together with Professor Warner of M. I. T., chairman of the new air board and members of the board made an official inspection of the new airplane field at Jeffries Point, East Boston. This field has long been considered ideal for such a location. During the summer the government began the construction of two hangars, which at the present time are practically completed. These hangars are intended to hold the ships now in the canvas hangars at Framingham. The field as it is being laid out has two runways at right angles to each other, each being 1800 feet in length and 300 feet wide. This construction makes it possible for planes to take off and land into wind regardless of its direction.

Transmutation. Helium has been obtained from carbon by the use of tremendous heat and electrical pressure at the Sperry Gyroscope Laboratories in Brooklyn.

Experiments are being carried out under the direction of Preston R. Basset to determine whether the helium was merely discovered in the carbon or really a product of decomposition.

All data at hand substantiates the theory that the helium was produced by the actual breaking down of the carbon atom under such tremendous stress.

The New Navigation Canal at New Orelans was informally opened not long ago when the dredges from Lake Pontchartrain, and the Mississippi River, met. This event marks an important step in the development of New Orleans as one of the great seaports of the country.

Work was begun on the canal in June, 1918, and to date $18,000,000 have been spent on the project. The locks have been completed for almost a year, and ships have been built on the banks of the canal and launched into finished portions of it, while it was yet unconnected to the lake or river.

EDITORIALS

CONTINUUM

With this issue comes the beginning of a new year in the life of THE TECH ENGINEERING NEWS. We, of Volume IV, assume the duties and responsibilities of perpetuating the work which has been handed on to us by our predecessors. A word about the work is particularly appropriate at this time.

During the past year, a live and growing organism has developed into a broad, firmly established publication. Through the efforts of Volume III, THE TECH ENGINEERING NEWS has had a healthy increase of twenty per cent in size, at the same time showing a marked improvement in content. It is our aim to further this work of progress and to present to our readers each month a paper which will even better satisfy the unquestioned need for a good engineering publication at the Institute.

THE THESIS

In a recent issue of *The Coöperative Engineer*, there appeared a few words of wisdom concerning the thesis which we shall quote as being very applicable to the Institute.

"How soon, in the college course does the thesis actually get under way?" This is a vital question, as every engineering college in the country annually requires a thesis from each member of the graduating class.

Since the thesis is a requirement there is a tendency to look upon it as a necessary evil and to postpone attacking it as long as possible, and then to hurry through with it, once it is undertaken. A thesis written on this basis is probably not an important contribution to the world's store of knowledge. It may serve only to clutter up the shelves of the college library.

The student assuming such a view has overlooked one of his big opportunities. What the World's Series is to organized baseball, and the International Tournament is to golf, the thesis ought to be to the graduate. The comparison refers not to spectacular competition but to the one supreme chance to show outstanding merit.

The old adage "Well begun is half done" applies with special force to a thesis. The first step is to get an original subject that can be "sold" to the professors — a subject so plainly worth while that they will not want to assign something else as a substitute. If the thesis should arise within a firm with which permanent connections are desired after graduation, there is an added incentive.

PHYSICAL EDUCATION IN THE COLLEGES

More and more, colleges and universities are conceiving it their purpose to produce well-balanced young men. They are perceiving that to do this some attention to physical education, development and well-being is required. To what extent colleges should strive to attain a high physical standard among their students seems not to have been decided. There appears, however, to be tremendous room for improvement of the average college man from a physical standpoint.

The matter is handled probably in nearly every school in the country save perhaps the Military and Naval academies, in much the same manner as at Technology. In the first place, there are the required gymnasium classes. This sort of thing generally is extremely inefficient. The most potent reason for this is that for any benefit to be obtained the man needs to have an interest in the work as well as an ability to go through the prescribed movements. They alone are of no value whatever. An interest in seemingly meaningless arm, leg and body movements is a difficult thing to obtain. The spirit of play is lacking, there is no obvious incentive.

In the second place, there are the athletic teams. They are without a doubt an excellent institution for the men who make them, but everyone cannot be varsity material. Hence men who would derive great benefit from the work with these teams do not try for them because they feel disqualified before they begin. The varsity athletic teams thus have a tendency to develop only those men who already are above the average. From the standpoint of the problem of physical development of a student body as a unit, this is unfortunate, but it is to be remembered that varsity sports do not have such development as their aim. For any sport to remain in existence, its teams must be at least moderately successful. Success in competitive sport requires individuals above the average and from this point of view the varsity sports are justified in developing only the better men.

The fact remains that games and sports where interest is maintained by competition and the play instinct are probably the most potent means of securing physical improvement of a large group of individuals. The equipment, facilities, and personnel required to carry out a program developed on this principle would be large. The necessary investment might not seem worth while, but the tendency must be in that direction. Physical development and perfection may not seem so very important at first blush.

Everywhere one hears of promising young and middle-aged men, who seem to have great futures ahead of them, passing suddenly from the realm of the living, from natural causes. Realization that many of these promising lives might be saved us, that mental vigor can accomplish naught without physical vigor, that health is the finest asset for happiness, makes a great expenditure seem not so large after all.

It should be appreciated that by physical development we do not necessarily mean development of great rolls of muscle. A sound set of internal organs is a more basic factor for health than muscle, but we do mean a moderate muscular development and an excellent development of the heart, lungs, and stomach.

This brings us to another side of the matter. It is quite evident that one should have some knowledge of anatomy and physiology if one's body is to be kept at its highest efficiency, yet how little the average person knows about himself! It would seem most appropriate for a good, modern, scientific course in physiology to be included among the subjects required for graduation from our colleges. At present whatever the average student knows of this has been learned in grade schools where the subject cannot be treated

as fully or as well as it might be in the college classroom.

The oft-cited army tests showed that despite American traditional physical excellence, American actual physical excellence is quite another thing. It seems to us that more and more attention will be given to physical improvement in the future and that college faculties would make no mistake in investigating, with a view to positive action, this interesting and important problem.

E. C. M. A.

In the summer of 1921, a little group of far-sighted individuals led by Ray St. Laurent, General Manager of THE TECH at that time, came together with the idea of forming some sort of an association of engineering college publications. They realized the advantages of unity and coöperation in this field. They felt that every technical school needed a real scientific journal and that the realization of this was only possible through the coördinated effort on the part of those concerned. As a result of this small, informal meeting, The Engineering College Magazines Associated was founded.

A short survey of the accomplishments of this organization will serve to indicate how well it has fulfilled its purpose.

Eighteen technical publications of engineering colleges all over the country have been brought together in this group. They have conformed to high, set standards in size, cover, paper, make-up and content. Each has, according to the aim, greatly improved in quality without losing individuality. In the details of publishing, they have, as a group, gone far ahead of anything which one member alone could have produced.

Through the operation of this Association, collegiate technical publications have been brought before the public as a medium for national advertising. Conformation to an advertising policy, restricted to engineering and industrial advertising has convinced national advertisers that this group is the best medium through which to reach the undergraduate engineer, and its value has been sustained.

Not only have collegiate technical publications been brought before the national advertisers; but equally important, they have been brought to the attention of the foremost technical writers in the country. This has made possible the adoption of a strict engineering editorial policy, and has rendered the undergraduate engineer a valuable service, for he can be sure that an article appearing in one of the group papers has been written by some one who knows the subject.

In connection with this, the Chairman of the group reviews each issue of each member, checking up on content, make-up, and quality. He sends a report to each member giving helpful criticism and praise together with suggestions for the improvement of future issues. He is governed in his reviews by the standards of practice adopted by the whole group so that a unity of editorial policy is greatly facilitated.

In keeping with the growing and progressive nature of this organization, conventions are held each year at which improvements are made in both standards and policies. General discussions are held on editorial and advertising matters giving each member a chance to bring up its own particularly difficult problems for solution or helpful suggestions. Coöperation in common aims is the keynote of these conventions and much is accomplished.

The value of E. C. M. A. in making possible the present high standard technical publication at engineering colleges is very great indeed and a continuity of this value is looked for in the future.

A WORD FOR THE BROWNBAGGER

All Technology, to paraphrase Mr. J. Caesar, is divided into two parts, the activity men and the non-activity men. A certain type of this latter class has come to be known by all of the former by a term of approbrium that connotes lack of school spirit, selfishness, and other unsavory qualities. This term is "the brownbagger."

As commonly conceived men placed in this category had rather study than eat; to them class and school affairs outside the classroom are non-existent. That they should arrive at the correct answer to some problem in applied mechanics is to them of much greater importance than that the athletic teams need more support from the student body. And so on.

This, we said, is the common conception, but a little careful investigation shows that the average brownbagger is not such a self-centered sort of person after all. And what is more striking, it is discovered that a very, very great number of them are brownbaggers because they have to be. They find that they have the problem on their hands not only of getting an education but also of getting a living. Some of them to obtain both these things have laid out and follow schedules of work that appear to be physically ruinous.

After all, it is a matter of fundamentals. A man ostensibly comes to Technology for the academic training he expects to receive. If he have the opportunity and inclination to go into activities, well and good. Activities are undoubtedly a broadening influence. But more lenience by this man toward his less fortunate schoolmates who may have the inclination but certainly have not the opportunity for activity work will not be amiss.

The brownbagger deserves more consideration than he usually gets, and many of them are entitled to a great deal of respect for their determination to obtain an education despite the obstacles in the way. So it is rather likely that the brownbagger should get a word of commendation, a bit of praise, instead of the slurs which constitute his more usual lot.

BOOK REVIEW

Plane Table Manual. Washington: Superintendent of Documents, Government Printing Office. 1923. 97 pages, $0.25.

The United States Coast and Geodetic Survey, Department of Commerce, has issued a revised edition of the manual of instructions for topographical surveying with the plane table, which embodies the most recent practice and is in convenient form for the use of engineers, surveyors and others engaged in the work of mapping and engineering construction.

This publication, known as the Plane Table Manual, is published in a small volume of 97 pages as Serial No. 179, Special Publication No. 85. It may be obtained free of charge by persons interested by application to the office of the Coast and Geodetic Survey, or from the Superintendent of Documents, Government Printing Office, Washington, at the nominal price of twenty-five cents.

The plane table, which is fully described in this publication, has been used in the Coast and Geodetic Survey since the commencement of the work as affording the most simple, direct and expeditious means of making a topographical survey, and it is used to a considerable extent by other branches of the Government in which surveying work is done.

The description of the instrument is preceded by a historical note giving the gradual evolution of the plane table and its attachments, and is followed by an explanation of the various problems occurring in practice and the methods used in the field work.

The manual is illustrated by forty-eight cuts and diagrams explanatory of the instrument, its practical use, and the symbols used in representing topographical details, and includes various useful tables.

OPPORTUNITIES IN MARKETING FOR THE ENGINEER

(*Continued from page 12*)

The engineer, too, has devised ways to overcome seasonal factors limiting production and has developed new uses for products. He has done good work in securing the assent of the sales department to changes in products that have directly cheapened costs due to faulty design or unnecessary processing.

In the field of market research, the engineer has made surveys and analyses of trade channels and has furnished the facts for changes in distribution methods that have reduced the costs of marketing. He has dug out the facts of the geographical locations of consumers and has plotted the distribution of consumers and dealers to show the relative efficiency and costs of physical distribution by territories. The cost of each factor in the chain of distribution has been a fertile field of study, and new methods have been devised to cut out the wastes discovered. Particularly successful has been his study of the methods of packing and of the merchandising features of packages and in this field he has tremendously cut down the wastes of operation methods, of breakage in transit and of physical deterioration of products.

Another field of research into which the engineer has been called is that which comprises the discovery and analysis of the complex elements that enter into price determination. Only those who have been concerned in it can appreciate how technical are the considerations affecting price-fixing.

No true engineer is content to measure current performance solely against records of past performance. A standard of performance is a goal attainable under normal, standardized conditions. So we find that preceding the establishment of standards of performance must come a clear delineation of the conditions beyond the company's control, an analysis of their stability, and a further analysis of the factors affecting stability and the current trend of those factors. This is a matter of technical research, reaching into the fields of economics, statistics, psychology and sometimes into biology, meteorology and other branches of science. Turning to the field of the company's own marketing efforts, we find the necessity for standardizing the operations of the marketing organization and establishing standards against which to measure its efficiency.

A beginning has been made by the engineer in setting standards in marketing but it must be remembered that these are set upon bases that are faulty and incomplete. This, however, does not vitiate their usefulness. The facts gathered are in themselves reasonably accurate and the tests so far show that, though incomplete, the data based upon skilfully selected portions of the field are sufficiently accurate to furnish indices and averages of the whole field under study to the degree that commercial activities based upon them are subject to far better control than is possible when no standards are used. The government agencies, the trade associations and the investigators for industrial enterprises are slowly building up a mass of facts that will make our marketing data more complete year by year and which by the application of scientific statistical research methods will enlarge our knowledge of marketing efficiency.

Just what are our marketing engineers attempting to do in the field of standardization? First they are standardizing the practices of the marketing organization by compiling manuals of operations. Many forms of organization prevail in the marketing divisions of industrial companies. In general the widely recognized divisions are: Selling, merchandising, advertising, sales promotion, and credit.

In the selling division we find, manuals of standard practice in both field work and office routine; in merchandising, manuals of warehouse practice and accounting practice; in advertising, manuals of office routine; in sales promotion, of methods of handling inquiries and correspondence and of methods of assisting distributors of the company's products.

In matters affecting sales volume, we find quotas set up for the potential sales volume of each territory, standardized routes, standardized sample equipments, standardized portfolios of advertising and of dealer helps, standardized frequency of call upon distributors or consumers, standardized forms of reports, and standardized bonus or incentive forms of compensation.

In matters affecting marketing expenses, we find standard budgets for each division, standards of expense for fluctuating volumes of sale, standards of expense for materials used in sales work, and occasionally standards for salesmen's traveling expenses.

In matters affecting merchandise, we find standards for rates of inventory turnover, for maximum and minimum stocks of product items, for placing stock orders on the factory in economical production lots, and for packing methods and packing cases. We also find time standards for warehousing and invoicing operations as a basis for incentive forms of wage payment.

In matters affecting accounts receivable we find standard ratios of accounts receivable to sales volume (employed as a measure of the credit division's efficiency) and standard office routines.

This listing of standards is by no means complete. Neither is it to be assumed that the use of such standards are common. The characteristic of marketing today is the absence of standards; it is only the more advanced marketing organizations that have gone any distance in this direction. It is virtually a virgin field for men of the engineering type. The results achieved in the few companies far advanced in this work have been little short of astounding.

One Massachusetts manufacturer, doing a business of thirty million dollars a year and employing over eight thousand people on five different lines of products, closed the year of 1922 with a variation of a small fraction of one per cent on totals predetermined twelve months before for sales volume, expense, inventories, and accounts receivable. Production and financial programs can be safely arranged months in advance with such accuracy of sales control. The man who planned the basis for this control is one of our best-known industrial engineers, and the man who adapted it to his needs and executed the program, graduated in the chemistry department from Massachusetts Institute of Technology and established his reputation as a chemist long before he became a sales executive.

The consumer in the long run tells the manufacturer what he shall make, when he shall deliver it, and what he shall get for it. The marketing function is that part of industry which comes in contact with the consumer and must interpret his demands to the functions of production and finance. Thus industry must look to the marketing function for its master plans.

Slowly this conception has gained ground. In a few instances we find the engineering group in marketing segregated into a staff organization, formulating the master plans upon which management coördinates the activities of the business. With increasing frequency we find engineers in the work of research and of merchandise control.

Management has absorbed the lesson of the usefulness of the engineer in production in the fields of invention, of processing, and of systematization. Can we wonder that management is now turning to the engineer to cut down the disproportionate costs of marketing? That he is also asking the engineer to broaden the uses of his products, to expand the borders of his

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A TWENTY-FIVE MILE AN HOUR OFFICE BOY

(*Continued from page 11*)

the air flows through the tubes running from the central station or dispatching desk to sub-stations, through the sub-station terminals and back to a point at the central station where it leaves the tubes through special fittings and passes on to the intake opening of the compressor. The dispatching tubes are connected up in pairs, each of which lead to a separate sub-station in the same general direction. The two sub-stations are served by the same return tube, a side inlet terminal being provided at the station nearest the central point permitting the return of carriers from this as well as the station farthest away from the central station.

At the central dispatching station each pair of tubes is fitted with a double clapper door which always keeps the receiving end of either one or the other tube sealed, leaving the other tube open to receive carriers. The carriers are separated from the air current near the terminals, at the points where the air is drawn from the tubes through the terminal heads and continue by their own velocity or gravity through the discharge doors in the terminals.

The carriers travel at an average rate of thirty to forty feet per second and in some cases transverse nine stories or a vertical distance of one hundred twenty feet.

The system is comprised of twenty-six sub-stations located in both the office and merchandise buildings, besides the central dispatching desk located in the basement of the office building near the power unit, which makes a most simple and efficient power piping arrangement.

A rather surprising development was the result of terminating the exhaust pipe from the blower just outside the basement wall of the office building, in a court between the office building and merchandise building. Although the buildings are separated by a clear space of eighty feet, the pulsations of the exhaust of the compressor were so great as to cause a continual nerve-racking vibration in all the windows of both buildings facing on the court. The extension of the exhaust pipe to the roof of the three-story office building eliminated this trouble by permitting the compressed air to escape into the unrestricted atmosphere.

CENTRAL DESPATCHING DESK
Showing clapper inlets (two way) for selective despatching to two sub-stations served by the same return route.

The original cost of a system of this size and type is approximately fifty thousand dollars, but the service it renders makes it worth several times this amount. How many office boys would be required to replace the system and could any number of them satisfactorily fill the same requirements? Hardly.

There are two other types of pneumatic tube systems built, one of which is the straight pressure type, and the other a combination of vacuum and pressure. The type of system best suited for each installation must be determined by the conditions under which the system must operate and the service it is to render.

In the pressure type compressed air is used to force the carriers through the tubes. The pressure is obtained direct from the exhaust outlet of a low pressure compressor but in cases where there is a high pressure tank in the building, such as ordinarily found in garages or factories, the pressure is stepped down to four or six pounds through valves into a second tank from which it passes into the tube system.

The vacuum pressure type system is exactly what the name implies. Both sides of the compressor are connected with the system, the air being drawn from the tubes acting as return lines from the sub-stations to the

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OPPORTUNITIES IN MARKETING FOR THE ENGINEER

(*Continued from page 20*)

market, to help him plan so that he will not find his liquid capital tied up in frozen inventories as it was in 1921? The answer is obvious.

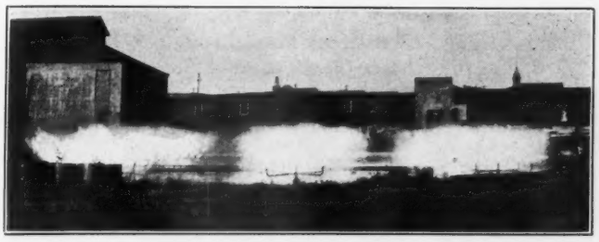
Management is asking the engineer to set up standards so that it may measure its marketing performance; to measure market demand so that it may make accurate production and financial programs; to schedule market demand so that it may schedule production to assure adequate merchandise inventories with the speediest merchandise turnover; to expand its market and sales volume to increase its capital turnover; to set up standard budgets so that it may control expenditures; to set up standards of operations so that operating efficiency may be determined; to systematize reports and routines to make control as automatic as possible; to determine trends affecting the industry as a whole; and, in general, to do master planning months in advance of current activities.

Certainly no small task; surely a great opportunity.

The roster of graduates of the Institute shows that a considerable number eventually become managers of industry. To such men the change from the seller's market of 1897–1920 to the buyer's market of the last two years makes marketing the major interest of industry. The fact that we have for some time lost a large part of our export market and that we have production facilities in excess of our domestic market need, can only mean that we are facing a period of great competition for our domestic market. Under such conditions there is no place for the "average" manager.

Another considerable portion of our graduates are engaged in marketing work and many are marketing managers. The wastes of intuitive sales leadership can no longer be tolerated and the demand for the analytical, thinking, fact-finding and fact-using marketing executive is insistent. That means a call for the technical graduate with executive capacity.

The great advances of social progress rest largely upon the work of those engaged in scientific research. The Institute must continue its splendid record in training men for that great field of endeavor. But to make the achievements of the research worker available to society is largely the work of industry. We have a great responsibility in furnishing leaders for industry — of which marketing is a major function.



The Above Illustration Shows the

Spraco Cooling System

In connection with the Municipal Power Plant of the City of Dothan, Alabama, capacity 3,000 gallons per minute. Note the uniform spray, even distribution and clear air passages. The Superintendent reports that when carrying full load in the hottest days of summer they never obtain less than 27 inches vacuum. In November last they were running with 29.6 inches vacuum. They changed from the old spray system to the new "SPRACO" inside of forty-eight hours.

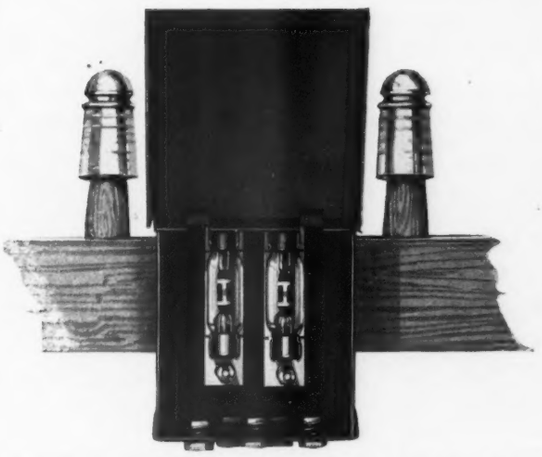
Spray Engineering Company
General Offices, BOSTON, MASS., U. S. A.

Engineers for
Spray Cooling Systems
Irrigation Systems
Aerating Reservoirs
Air Conditioning
Gas Washing

SPRACO PRODUCTS

Manufacturers of
Air Washing Equipment
Spray Cooling Equipment
Paint Spraying Equipment
Flow Meters
Park Sprinklers

NOZZLES FOR ALL PURPOSES



Operating engineers—particular in safeguarding their property—always specify

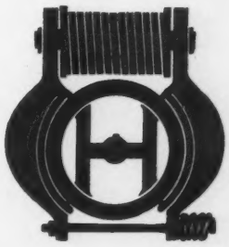
VAC-M ARRESTERS
IN
VAC-M CONTAINERS

for the protection of low voltage circuits because with them they can have uninterrupted service; intact equipment; positive protection against static; lightning; crosses; and grounds.

Write for details

National Electric Specialty Co.
Toledo, Ohio

HAUGHTON ELEVATORS



ECONOMY

There is no economy apart from quality. There is no saving except from durability and efficiency.

Real economy in elevators can be obtained only from equipment rendering long and constant service at the lowest cost of operation and maintenance.

Haughton Elevators are designed throughout for the greatest durability and efficiency, without regard to first cost.

An installation of Haughton Elevators is true economy.

A folder on the subject of the use of alternating current in high-speed passenger installations will be sent on request to Department T.

THE HAUGHTON ELEVATOR & MACHINE COMPANY
TOLEDO, OHIO

Toledo	*Cleveland*	*Youngstown*
New York	*Detroit*	*Lima*
Pittsburgh	*Akron*	*Oklahoma City*

RECENT DEVELOPMENTS IN ALASKA

(*Continued from page 13*)

conditions of transportation to the Territory than had California and the Northwest during the early days of their development. Even after the completion of the first transcontinental railroad to San Francisco, the Northwest, supplied through San Francisco, met infinitely slower service and higher rates than are encountered in Alaskan traffic today.

In transportation Alaska is, as was the Northwest up to the time of the completion of the Northern Pacific, an overseas country. Supplies required from the United States are largely obtained by shipment from the Northwest cities, chiefly from Seattle.

Using the "Inside Passage," vessels ply the route Seattle to Seward or, in summertime, to Anchorage. This route, while somewhat longer than the direct route across the Gulf of Alaska to Seward, enables the traffic of the Territory to be considered as a unit except that portion originating on the Seward Peninsula near Nome. These overseas vessels are the chief elements in the Alaskan commercial system. Serving them and tributary to them, reaching into the interior, two substantial railroads have been constructed and put in operation in Alaska. These are the Alaska Railroad from Seward at the head of Resurrection Bay on the south shore of Kenai Peninsula, to Fairbanks on the Nenana River, and the Copper River and the Northwestern Railroad from Cordova on the shores of Prince William Sound to Kennecott, the location of the large copper mine of the Kennecott corporation. Navigation reaches Cordova and Seward the year round. With the use of the Alaska Railroad the interior can be reached by freight and passengers at any season of the year. The interior rivers are only open for navigation five months of the year. As is well known, they served very largely in the early development of Alaska and are still of high importance.

River boats are regularly used from White Horse, the terminus of the Skagway and White Pass Railroad, to St. Michael, on Norton Sound. Separate routes are established and boats ply on the Kuskokwim, Koyukuk and Tanana Rivers. Serving all of the above and in truth the ultimate traffic link, are all kinds of overland transportation, from wagon and auto roads, to summer and winter trails, sled roads, bridges, cableways and trams. These, due to the pioneer state of the country and the peculiar development of its first industry, mining, vary from the very lightest improvement necessary to help the prospector and isolated miner, to really excellent roads. One long, through road has been constructed from Valdez, on Prince William Sound, to Fairbanks, in the interior. Light automobile traffic can pass over this road in from two to three days during the summer months. The construction of all kinds of overland means of communication must be done, only after considerable study of the mining development involved and the topographic and climatic features encountered.

The great change brought about by the completion of the Alaska Railroad means new conditions as different from the old as were those which followed the opening up of the first through routes to the Northwest. Equally great changes will be looked for in that great interior country of Alaska. After placer mining is stimulated with the lower freight rates and more regular delivery of supplies, the quartz mining will follow and, with the latter, perhaps correlated industries, especially smelting.

The production of coal along the Government Railroad is already of high value for local supply. The development of coal mines for local sale and changed conditions in our own west coast might, at any time, be followed by a coal production readily absorbed in the Northwest.

The prospecting for oil in the promising seepages of Alaska is being aggressively carried on. The opening up of an oil field is a probability of the near future. The Alaska oil seepages are uniformly of a high grade refining paraffin base oil.

With the development of all of the former the agricultural effort can be extended exactly in proportion to the number of the mining and other industrial population introduced.

As in all development of pioneer country, the settlement and accompanying upbuilding is pyramidical; each helps the other. With more settled communities, originally founded as mining settlements, and improved transportation facilities, the population will more and more largely live within the Territory. In all of this the great step forward in our time is the Alaska Railroad. On this trunk line, at no small expense and with great effort and painstaking care feeding the same, numerous kinds of overland routes will have to be made. Some of these will, eventually, as always follows, develop later into railroad routes.

THE FIXATION OF NITROGEN IN FRANCE

(*Continued from page 8*)

operating on large volumes of gas with apparatus of large dimensions. The Claude Process, on the other hand, works equally well with small units. The large proportion of ammonia under high pressure makes it very easy to extract it by liquefication. It is sufficient to pass the gases through a coil of pipes immersed in water in order to obtain liquid ammonia, a product which has a greater market value than the aqueous solution of the Haber Process. Finally, since the same mass of gas occupies a volume five times smaller than in the Haber Process, and since the rapidity of the operation is very much accelerated, it is easy to see that for the same yield the dimensions of the apparatus are considerably smaller, a fact which permits the manufacture, without too great difficulty, of receptacles the walls of which resist a pressure of a thousand atmospheres.

An installation capable of producing five tons of ammonia a day consists of four catalyzing tubes weighing seven hundred kilograms each, or a total of about three thousand kilograms.

The catalyzer always has as its base iron or iron oxide which can be prepared in large quantities by a rapid process. To sum up, the characteristics of this ingenious process are: simplicity, small requirements as to space, direct production of liquid ammonia, and high efficiency in small units. This last point has a great importance with regard to the price of hydrogen necessary for the operation. It must be remembered that the problem of synthetic ammonia is, above all, a problem of raw materials, a problem of hydrogen; because for one part of nitrogen which the air supplies at little cost, three parts of expensive hydrogen are required. It is therefore the price of hydrogen which determines the price of ammonia. Now hydrogen is a by-product, at present largely wasted, of a certain number of existing industries, for instance, electrolysis for the manufacture of sodium, the manufacture of acetone and coking ovens, the gas from which

(*Continued on page 34*)

Detroit First

in Fire Alarm Protection

THE completion of the new Fire Alarm Headquarters shown above gives Detroit just claim to the honor of having the finest fire alarm protection in the country — and that means in the world. The new headquarters is located in an isolated building — fireproof throughout — with the most modern apparatus. Two thousand boxes on the streets give a greater protection per thousand population than is found in any other city. The panic spots — the schools, hospitals, theatres — each have a box for their protection. The leading industrial concerns have complete individual systems. Ford has a Gamewell System with four hundred boxes, Dodge Brothers has a two-hundred-box system, Cadillac and Morgan & Wright have two-hundred-box systems; the Durant Building has perhaps the most complete fire alarm system of any office building in the world. Five hundred smaller concerns have direct fire alarm connection with headquarters.

Detroit has the highest percentage of box alarms of any city in the country — and box alarms are the prompt and safe alarms. This equipment is Gamewell throughout and it has been a pleasure and a privilege to coöperate with the Detroit officials in building their equipment up to the point where it is the most complete in the world. The engineering knowledge that has gone into this equipment is at the command of any industrial or municipal engineer who is interested in more effective fire alarm protection.

The GAMEWELL COMPANY
Newton Upper Falls, Mass.

ROGER WARD BABSON

(*Continued from page 9*)

securities, sending messengers back and forth among the houses to swap "circulars." This involved an immense amount of work, and Babson immediately worked out a plan whereby he would act as a central bureau for these houses, compiling the same data for all, and selling the compilation on a monthly basis.

After much endeavor he succeeded in getting a few houses to subscribe to his reports, and in a year or two this work expanded until he had hundreds of banks and bond houses subscribing to his "Composite Circulars." These circulars were for years mimeographed and bound in ledger pages like engineers' specifications. Within a few years this business was combined with the Elliott Reporting Service in New York and the whole thing is now being operated in an elaborate book form by the National Quotation Bureau, 48 Front Street, New York City.

After a time he began to feel quite like himself, and moved his operations from his humble cottage to a small frame office in Wellesley Hills Square. For some time he had observed that the available data on corporation securities was not at all in an up-to-date form. There were, of course, one or two large annual publications, but no systematic way of supplying current information in the intervening months of the year. After some study, he began to issue on 5 by 8-inch standard size cards current data on the principal listed corporations. These cards were accompanied by a neat filing cabinet properly indexed. As fast as new information came in from any company, the corresponding card was revised and mailed to subscribers. The old card was then thrown away and a new card inserted in its place.

In this way investors and bankers always had their information up to date. A good business was immediately built up, thus giving him a second arm to his "Services." Knowing that certain Europeans were much interested in American securities, he next visited London, Paris, and other centers, in an endeavor to put these "Stock and Bond Description" cards on the market there. Though he met with fair success, he received across the water a suggestion which was worth more to him than all his previous business.

The big bankers said to him, "The information on your cards is all very well, Babson, but we have a good deal of this data which we have already compiled. What we really want you to tell us is something far more vital. We invest in your American corporations — your railroads and your industrials, and things are going swimmingly. Business is good, dividends are large, and quotations are mounting. We turn our backs for a little while, and presto — you are having one of those confounded panics over there, and everything has gone to the dogs! If you will tell us how fundamental conditions are in your country, we will pay you whatever you ask."

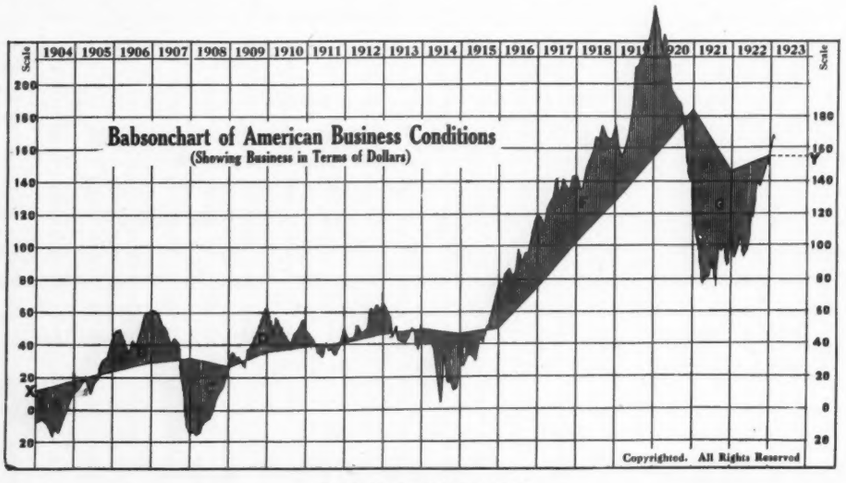
Enough said! Babson quickly asked them concerning the kind of data to be studied, came back home, and began a compilation of the fundamental indicators of American business. It was a long job. Not only did he have to select the correct subjects, but figures had to be secured over a sufficiently long period to enable the student to get the trend. Some figures were excellent indicators, but they extended back for only a year or two and hence were valueless. The tables finally grouped on the Babson Statistical Sheet are about thirty in number, comprising such subjects as Building, Bank Transactions, Labor, Foreign Trade, Investments, Commodity Prices Corporation Earnings, Crops and other Production items.

Shortly after the panic of 1907 this work began to develop rapidly. Here was something which the business man needed. He was eager to know how business really was — also, the probable outlook. As his clients increased, the next question they asked was — "Show us in some way what the net effect of all these fundamental factors is." After some study, then, he evolved a diagram by reducing the various figures to a common index, whereby the course of American business was graphically portrayed month by month and year by year.

This diagram was immediately of great practical value, and when a medial line showing the net growth of the country's business was superimposed on the diagram, a study of the picture suggested to him that Newton's great Law of Action must apply. That is, having developed an area of over-expansion above this medial line, the diagram always tended to develop a succeeding area of depression below this line of equal size, though not in shape.

His organization now comprised a personnel of some proportions, and included sales offices in the larger Eastern cities with agencies in Paris and London. He was still operating his circulars of Bond Quotations, his Bond and Stock Description Cards, and a Correspondence Course for investors and bond salesmen. In the meantime he had bought control of the Moody Manual and formed the Moody Manual Company. The demand for the Reports on Fundamental Conditions, however, continued with great vigor, and he sold out most of the other branches of his business to various New York people. The Bond and Stock card business, for instance, eventually lodged with the Standard Statistics Co., 49 West Street, New York City, and is now being operated by them. The Moody Manual has been recently combined with Poor's Manual and is now being operated under the name of Poor's Publishing Company, 33 Broadway, New York City.

(*Continued on page 28*)


1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923
Babsonchart of American Business Conditions
(Showing Business in Terms of Dollars)
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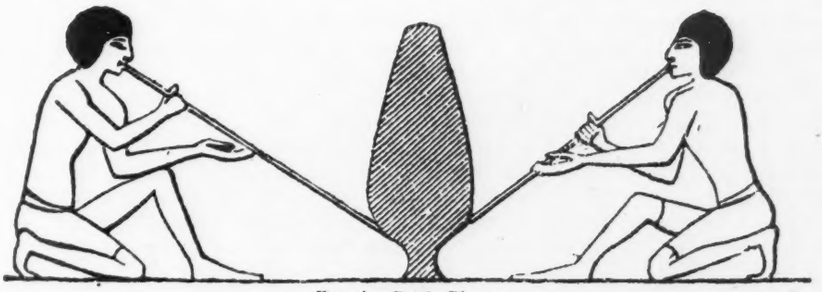
THE BABSONCHART

The above chart gives a picture of American business for the past nineteen years. It is based upon so-called "Business Barometers," such as new building, check transactions, foreign trade, money rates, failures, commodity prices, etc. These figures, when combined into a single Index Figure, indicate the relative changes in business conditions. The trend of this index makes the outline of the Babsonchart. The medial line marked "X-Y" represents the actual net growth in business in terms of dollar values. The areas above and below this base line show the degree of over-expansion or depression. They represent the action and reaction in business.



Egyptian Bottle Blowers

The Origin of Glass

PLINY tells us that some Phoenician mariners, while encamped on the banks of the River Belus in Palestine, discovered a very wonderful article — Glass. But Science disagrees with the philosopher, and claims that the Egyptians were making objects of glass long before the Phoenicians were even a distinct race.

These old Egyptians had to produce their ware under the most adverse circumstances. The labor involved in making even one object was tremendous and the time required made quantity production unknown. On the other hand, today, modern machinery turns out glass bottles so rapidly and in such great quantity that you wonder how they can all possibly be used. And the quality of the glass, rare as it was in 6000 B.C., is now even better, for scientific management and knowledge have played their important parts in the development of the industry. Thus are the two essential factors, quality and quantity, linked together with the result that glass may readily play its very necessary part in our everyday life.

THE SALEM GLASS WORKS, better known to its older friends as CRAVEN BROTHERS, one of the pioneer glass bottle manufacturers in this country, has steadily grown with the industry until today they are noted everywhere for their fine products, their faultless service and their absolute integrity.

SALEM GLASS WORKS

SALEM, NEW JERSEY

Nothing is impossible when it comes to making better goods or giving better service

ROGER WARD BABSON

(*Continued from page 26*)

Though he had been urged many times to move his location to Boston, New York, or some other large city, he still felt that the business of compiling information could be operated in an entirely successful manner in the beautiful and healthful surroundings of Wellesley Hills. Having outgrown his quarters in Wellesley Hills Square, he constructed in 1913 a large brick office building opposite the Wellesley Hills railroad station.

"Babson's Reports" were now attracting widespread attention. In addition to a bulletin on general business, and a large statistical sheet of tables, he expanded his publications to include bulletins on stocks, bonds, selling opportunities, commodity prices labor, and detailed industries. Calls now came in for his services as a lecturer all over the country and for articles in the various periodicals and newspapers. Business men were beginning to think and to study conditions as they never had before. Soon the building just erected proved insufficient. In 1917 a large tract of land was purchased down the street and another and larger office building erected thereon.

In the study of conditions he continued to make various trips to Europe, and Central and South America. The entry of the United States into the Great War called for experts of every sort, and Babson was duly installed as "Director of Information and Education" under Secretary of Labor Wilson. Throwing his whole soul into the work he organized a most efficient department and pressed for results with his customary energy. The "Steam Roller" they called him at the nation's capital during this hustling period!

At the close of the war Babson returned to the more active direction of his work at Wellesley Hills and to plan for further education of the American business public. The number of his clients had now increased to such an extent that it was necessary to establish additional field offices in various cities, and to enlarge his research and editorial staff. What he was constantly seeking, however, was some way to make the research idea a permanent contribution to public service. He felt the necessity of working out some program so that there would be no possibility that business men would ever again go back to "hit-or-miss" methods in place of systematic study of fundamental conditions. It was this basic purpose which finally led him to found the Babson Institute.

The Babson Institute, established in 1919, was incorporated under the educational and charitable laws of Massachusetts. In addition to President George W. Coleman and a strong staff of experts, it has the advice of a working board of trustees, supplemented by an advisory board of prominent men representing a great variety of lines of American industry and all sections of the country. Its founder has sought to emphasize the fundamental principles involved in finance, production, distribution, and personal efficiency, and train men so that they would be actuated by proper motives. This applies alike to all three groups — stockholders, executives, and wage workers.

It is supported largely by endowment and Mr. and Mrs. Babson have been heavy contributors towards its welfare. It will soon move from its present temporary quarters to a new campus of 160 acres, where eight buildings will be ready for occupancy. The layout calls eventually for a large group of buildings. Besides the customary equipment for college work, the plan is to have a separate building for each leading industry and also for each of the leading states. Babson's idea is that in these buildings the student will find assembled the fundamental facts and figures which will put him in touch with a given industry or a given locality.

In the resident division a group of young men receive personal and intensive instructions to fit them for positions of trust and responsibility. The first year course covers: Practical Economics and the Handling of Commodities, Financial Management and the Care of Property, Business Psychology and the Influencing of Men, Personal Efficiency and the Control of One's Self. The second year course continues the work by adding to these essential fundamentals the technical details of some one line of business. The extension division provides similar courses of training for those who, because of active business connection, are unable to attend the resident school.

Each year since 1914, a group of leaders in industry and business have met for a few days at Wellesley Hills to discuss current problems. The idea has taken root and has grown into a week's session attended by thousands of representative business men, and it is in the mind of the founder that these conferences will eventually be extended to cover the two months of July and August every year.

To strengthen these Wellesley Hills activities various specialized research companies are now being formed. The first of them are the Oil Statistics Company and the Retailers Service Company, destined to become powerful, educational aids in their respective fields. These research companies are all controlled by the Babson Park Company, which owns the land and buildings used by the Babson Statistical Organization. The Park Company, besides acting as a holding company for various Babson enterprises, also owns valuable securities and some two hundred fifty acres of the finest residential land in Wellesley and Needham.

(*Continued on page 32*)

What are you going to do this summer?

Take advantage of the Summer Session. You can get a lot done in a short time.

Those who are ahead can get through. Those who are even can get ahead. Those who are behind can catch up.

How about getting a little better prepared for the job you expect to have some day? Have you ever considered broadening your education by taking some extra laboratory or research work, or by taking subjects in other courses than your own?

Get a copy of the Summer Bulletin and look it over.

Massachusetts Institute of Technology
Cambridge, 39, Mass.

Teaching Engineering—a Real Man's Work

"Why are you satisfied to spend your days here when you might be doing bigger and more remunerative work with us?" The speaker was the Vice President of a big corporation, and he was addressing a great chemist.

The man to whom he spoke looked from his study window out over a well-loved campus for several moments before he replied. Finally his answer came, "I guess it's because I am more interested in helping to make *men* than I would be in just making *things*."

This thing of building men is one of the most fascinating vocations known. The pleasure that grows out of watching men develop, out of seeing them make effective use of the fundamentals that have been so carefully given them to use—it is doubtful if there can be any pleasure much deeper or more satisfying.

The teacher honors himself in the usefulness of his students. And the teacher of engineering, especially. His laboratory and his materials are in the minds of men. He shows them the right and constructive use of the senses and the memory in securing and storing information. He trains the judgment and the will to analyze and to decide. Little by little he develops the will to do, the ability to turn decision into accomplishment, the quality that always marks the successful engineer, who is a man who gets things done.

Westinghouse, and every engineering business, must acknowledge a deep obligation to those teachers whose training and interest have been an inspiration and a sure foundation for the individual successes that are constantly being recorded. And nothing that men or events may do can deprive the teacher of his rightful share of such triumphs!

Westinghouse

ACHIEVEMENT & OPPORTUNITY

W

WESTINGHOUSE ELECTRIC

THE EIGHT WHEEL CHASSIS

(*Continued from page 5*)

while in the eight-wheel truck the four rear wheels carry only about 55 per cent of the load. Therefore, wheels and tires may be comparatively small, effecting economy and safety of operation. The center of gravity of the car being correspondingly low, these vehicles are less liable to slide off the road, or overturn on sharp curves, taken at continuous speed.

The two front axles are connected by springs on either side, so arranged that the axles oscillate about a central trunnion bar. If one tire blows out — or even if a whole wheel comes off — the loss is so taken up by the interrelation of the four wheels of the front set, that the steering ability is not materially affected.

The flexibility of the eight-wheel construction is such that when the wheels on one axle roll over a bump, the body is raised only half as high as would be the case with the ordinary four-wheel chassis. Considering the eight-wheel vehicle, suppose the leading wheel of the front set goes into a hole in the road four inches deep. Its axle drops four inches. The following wheel of the front set still remains on the level, so its axle does not drop at all. Therefore, the trunnion, midway between the two axles, drops but two inches. Yet the time it takes the leading axle to drop four inches is the same as that taken by the trunnion in dropping two inches. Therefore, the velocity of drop of the axle of the leading wheel is twice as great as the velocity of drop of the trunnion. Since the force of impact is directly proportional to the energy of motion, which in turn is directly proportional to the square of the velocity, according to the formula $E = \frac{1}{2} m v^2$, and since the velocity of drop of the axle is twice as great as that of the trunnion, the energy of its motion would be as the square of four is to the square of two, or as sixteen is to four. In other words, the bump or jolt upon the body of the eight-wheel car is only one-quarter as great as is the case with a four-wheeler. It is this fundamental principle that accomplishes the comfort of the eight-wheel bus. It also makes possible the safe transportation of perishable goods, such as fruit, upon which there is great loss from bruising when hauled by four-wheel trucks.

Since there are four rear driving wheels on the ground, the tractive effort is double that of the usual two-wheel drive. Also, by the inter-construction of the driving axles, each wheel holds the road better than the two driving wheels of the usual four-wheel vehicle. When a four-wheel chassis runs over a bump, or jumps a rut, one or both rear wheels will be slightly off the road, and tend to run ahead or behind the rest of the car, according to whether the motor is pulling, or the brakes holding back. Upon return to the road a slight skidding or slipping occurs, which not only jars the passengers uncomfortably, but causes extra wear on the tires. Through the prevention of this slippage and other economies a saving of 15 to 25 per cent in gasoline consumption is made possible.

There is a separate brake upon each of the eight wheels, so that the safety factor is four times greater than on the ordinary four-wheel car. Furthermore, the brakes are operated by compressed air, in the same manner as those on a railroad train, enabling the driver to stop a fully loaded bus quickly, and without physical exertion, no matter what the condition of the road. Also, since the brake area is so much greater than usual, the effect required of each brake lining is correspondingly less.

Another innovation in the eight-wheel vehicle is a transmission providing eight speeds forward, and two reverse. In every speed the transmission is practically noiseless, and free from vibration. Passenger-carrying service requires frequent stops, so that the only way to maintain a fast schedule, without traveling at too high a speed, is by quick acceleration in starting. Also, it is desirable to operate the motor at its most economical speed. The usual four or five speed transmission is not sufficient for these requirements.

These new principles of construction enable the eight-wheel vehicle to operate with safety, comfort and economy, while preventing unnecessary destruction of public roads.

The National Axle Corporation of San Jose, California, is beginning to commercially manufacture these trucks and hopes to find ready market for them with the various large bus companies.

BEMIS BRO. BAG CO.
CLOTH AND PAPER SACKS
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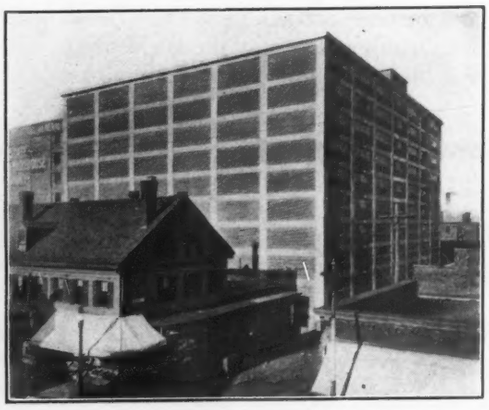


WILLIAM T. REED CO.
Building Construction
200 DEVONSHIRE STREET, BOSTON

We are organized and equipped for the efficient handling of mercantile and industrial building construction of all descriptions

Formerly New England Concrete Construction Company

Iron and Emery Cast Together!

FERALUN
Anti-Slip Treads

Approved by Underwriters Laboratories & Casualty Liability Insurance Companies

When making details or writing specifications it is well to have in mind some of the important applications of **Feralun.**

Coal Hole Covers
Area Covers
Gutter Plates
Elevator Door Thresholds
Freight Elevator Landings
Floor Plates
Ramps
Stair Treads { Superimposed / Inserted / Complete
Trench Covers
Shipping Platforms
etc. — etc.

For tread surfaces of more distinction and beauty and particular qualities, bronze and aluminum are used instead of iron as the metal into which the abrasive is cast.

Send for Samples

AMERICAN ABRASIVE METALS CO.
50 CHURCH STREET, NEW YORK CITY

No headaches

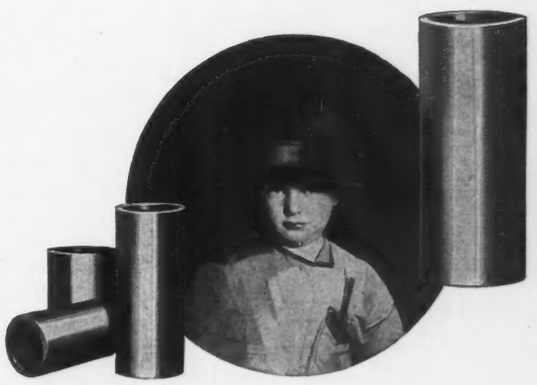
where Atlas Ammite is used

Atlas Ammite Explosive *will not cause headaches* from handling. Think what this means to blasters who have endured for years the sickening headaches caused by certain kinds of dynamite.

Atlas Ammite is an "all-'round" explosive. It is made in different grades to suit various conditions; it has abundant power and is safe to handle.

ATLAS POWDER CO.
WILMINGTON, DELAWARE

A PROPER EXPLOSIVE FOR EVERY BLASTING REQUIREMENT



"The more you use the more you save"
—Baby Bunting

Now you can use more Bunting "Ready Made" Bushings

The 114 new sizes just added to Bunting's "Ready Made" Bushing Bearings give you a vastly increased opportunity to cut production cost and upkeep expense.

Remember, there are now 268 different sizes of completely machine finished Bunting Bushing Bearings always ready for instant delivery in any quantity. This wide range of sizes meets almost every conceivable need. The price is low. Generous stocks at the factory and Bunting Branches in New York, Chicago, Boston, Cleveland and San Francisco.

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Write for stock list No. 1 showing sizes and prices of 268 different sizes of "Ready Made" Bushing Bearings.

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Pattern and tool equipment for over 10,000 different designs. Cored and solid bars of Bunting Phosphor Bronze.

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Main 5991

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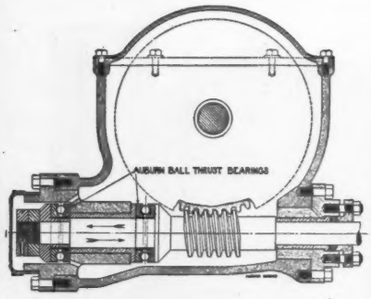
Main 8488

BUNTING
BUSHING BEARINGS



WORM DRIVES

operate more smothly when equipped with

AUBURN BALL THRUST BEARINGS

Write for loose leaf Data Sheets

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44 Elizabeth Street

ROCHESTER, N. Y.

ROGER WARD BABSON

(Continued from page 28)

This, briefly, is the Babson vision. Through all his endeavor he has emphasized the fact that the one great cause of social and business troubles is the lack of understanding between the employer, employee, and the general public. He believes that true religion is really the foundation of all business and social success. In several of his books he has brought this question to the front. Notably among them are "Future of the Working Classes," "Future of the Churches," "Fundamentals of Prosperity," "New Tasks for Old Churches," "Religion and Business," and "Enduring Investments." Others of his books are his first and monumental work, "Business Barometers," also "Future of South America," "W. B. Wilson and the Department of Labor," "Making Good in Business," "Business Fundamentals" etc.

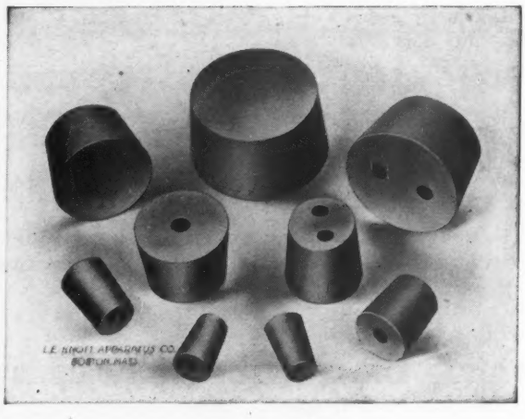
In addition to this and to his Reports to twenty thousand clients, he constantly reaches about five million people through the public press. One would think that with all these activities there would be nothing left of Roger, but not so. He is Vice President of the Manchester Trust Company, Vice President of the Adirondack Power and Light Corporation, Director of the Mississippi River Power Company, Director of the New Mexico and Arizona Land Company, and Chairman of the Board of the Eastern Massachusetts Street Railway Company. He is actively interested in the American Statistical Association and the American Economic Association, being an ex-officer of the latter organization, and a Fellow of the Royal Statistical Society of London.

A man of unbounded energy and one who has done more than any other one man to make statistics a live issue in business and to get real vision into business men, is Roger W. Babson. His life work may well be summed up as the application to business and human affairs of Newton's great basic law which he learned at Technology. Let us say it in Babson's own words:

"*As in mechanics and economics, so in human relations every action is followed by an equal reaction. This means two things:*

(*1*) *That what we get out of life is simply a reaction from what we put into it.*

(*2*) *That we cannot harm or help others without likewise harming or helping ourselves.*"



Standardized Rubber Stoppers

In Size

The stopper number shows the diameter in millimeters of the small end. "K28" is an excellent fit for a 500 cc. Pyrex flat bottom flask.

In Composition

Formula 317 assures lasting resiliency in all Knott Rubber Stoppers.

Send for price-list

L. E. Knott Apparatus Company

Scientific Instrument Makers

Cambridge, Mass.

Printing that wears—

Printing that demands and obtains attention, that pleases the eye, that delivers its message wherever sent—that does its work well.

Such printing has many things in common with the engineering products that wear. Both are the result of intelligent planning, the best of materials and the most skillful workmanship. Both are invariably worth all they cost because they best serve their purpose.

We always keep in mind the purpose for which each piece of printed matter is intended, so that the finished product may do its work well.

THE MURRAY PRINTING COMPANY

KENDALL SQUARE, CAMBRIDGE

Silver for Hiram of Tyre

Hiram of Tyre was the metal king of the world in the tenth century, B. C. From Spain, his fleet brought back every third year the entire production of what is now the Rio Tinto Mine.

Three tons of silver a year was all that 40,000 workmen could produce in Hiram's time. In a recent year, at the same mine, 9,000 men, with the aid of explosives, mined 2½ million tons of ore. From this ore, almost 30,000 tons of copper alone was obtained.

But the cost of time and labor are so much higher now than when King Hiram worked the Rio Tinto that even dynamite, as great a labor saver as it is, must be scientifically selected and used.

On work for which it is suited Hercules Special No. 1 is more economical than the usual grades of dynamite. It contains about one-third more cartridges per case than 40% dynamite which it often replaces, cartridge for cartridge; at a saving of about twenty-five percent in blasting costs. It contains nothing but the highest grade of standard materials and by wide use on many kinds of work has proved its dependability.

To help you in using explosives most effectively, we have prepared a series of practical booklets. If you have not yet received them, write to our Advertising Department, 939 King Street, Wilmington, Del., for free copies of "Eliminating Waste in Blasting", "Scientific Quarry Blasting", and "Hercules Products".

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St. Louis, Mo.
Salt Lake City, Utah
San Francisco, Calif.
Wilkesbarre, Pa.
Wilmington, Del.

THE FIXATION OF NITROGEN IN FRANCE

(*Continued from page 24*)

comprises fifty per cent of hydrogen. It would certainly bring about an economy if we were able to erect in the neighborhood of each of these sources of hydrogen a small plant for making synthetic ammonia.

Carbon monoxide boils at −190° C., hydrogen at −250°. The difference in the volatility of the two gases is therefore very great and the separation comparatively simple. The mixture is compressed to twenty or twenty-five atmospheres, cooled, led to the bottom of a bank of tubes surrounded by liquid carbon monoxide at −190°. Under the combined effect of this temperature and of its own pressure, a large proportion of the carbon monoxide of the mixture is liquified and goes to replace the external cooling liquid as the latter evaporates. What remains of the carbon monoxide is liquified in the upper portion of the tubes which are surrounded by hydrogen at a still lower temperature, namely −205° to −210°. Pure compressed hydrogen at a low temperature remains at the outlet, and it is this hydrogen which, expanded in a motor and further cooled by this expansion, is sent back around the tubes mentioned above at the very low temperature of −210°. To cool hydrogen in this manner, one could evidently not use an expansion without external work because hydrogen heats itself in such an expansion, constituting in this respect an exception to the behavior of other gases such as nitrogen and oxygen. It is therefore of prime importance that the expansion be accompanied by external work, namely in a motor. But here arises the very serious difficulty of lubrication. Claude had already met with this difficulty in the production of liquid air by expansion accompanied by external work. In this process, the motor was working at a temperature of about −190°, a temperature at which ordinary lubricants are frozen. The difficulty was solved first by the use of petroleum ether, then very cleverly by the use of the liquid air itself which was produced in the cylinder at the end of each expansion. In the present case, where the temperature has to descend to about −210°, even petroleum ether is frozen. Moreover, the lubrication cannot be taken care of by hydrogen, which becomes liquid at a temperature far too low, namely −250°. Claude had the ingenious idea of using nitrogen as the lubricant. This gas becomes liquid at −195° and only solidifies at −210°. One cannot, therefore, go below −210° in this manner, but this temperature is sufficient. The hydrogen being destined for use in the manufacture of ammonia, there is no objection to a little nitrogen being mixed with it. Five or ten per cent of nitrogen is mixed with the hydrogen before the latter enters the motor.

It would obviously be premature to compare the Haber and Claude Processes from a commercial standpoint. The Claude Process consumes more power. The synthesis of one kilogram of ammonia starting with water gas would doubtless require 3.3 horse power hours as compared with 2.4 by the Haber Process. This increased expense, however, is compensated for by the simplification of the equipment and the greater ease of operation, representing a reduction in the initial expenditure, in the labor cost, and in the cost of up-keep. Take all in all, there does not seem to be a very marked difference in the ultimate cost of the product between the two processes, but whereas the Haber Process is really practical only on a large scale, the Claude equipment is more flexible, adapting itself to small units and to the use of by-product hydrogen. By obtaining the hydrogen from the gas of coking ovens, it will undoubtedly be possible to effect a considerable economy in the future.

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Boston Chicago

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EVERY engineer should know APOLLO Best Bloom and Apollo-Keystone Galvanized Sheets, American Bessemer and Open Hearth Steel Sheets; and KEYSTONE Copper Steel

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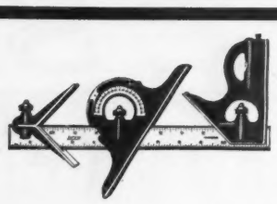

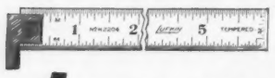

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KREOLITE

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EVERY industry has its own difficult floor problems. Our many years of experience with all kinds of floor problems is your protection against mistakes. Architects, engineers, contractors and plant managers continually welcome the aid of our factory floor engineers, both for new and old installations. It is *yours* for the asking.

Kreolite floors have established themselves as the *one* floor surface best qualified to meet every condition.

What could be better proof of their durability than their record of long life in railroad shops? Experience with all kinds of floors has proven the superiority of Kreolite block to twenty-eight different railroad companies, not only for heavy traffic, but for alternate wet and dry conditions. The Pennsylvania, for example, has placed forty-seven repeat orders. And if ever a floor was called upon to perform an Herculean task it is in railroad shops. Tons of ponderous weight, year after year of grinding strain, and a constant terrific abuse, give Kreolite floors the supreme test to prove their worth. The tough end-grain of the wood resists wear. The thorough impregnation of the block prevents decay and disintegration. Patented grooves anchor Kreolite floors solidly together.

There is no need for you to *experiment* with floors. You can know in advance exactly the kind of floor to lay that will *permanently* settle your factory problem. You *must* have a floor — why not get the one with the greatest durability, the lowest maintenance cost, smoothest to truck over, most comfortable for workmen, and best adapted to the peculiarities of your industry?

Outlast the Factory

Kreolite Redwood Block Floors

Write us for details regarding our Kreolite Redwood Block Floors.

The Jennison-Wright Company
86 Kreolite Building Toledo, Ohio
Branches in All Large Cities

WOOD BLOCK FLOORS

GRAIN ELEVATOR

(*Continued from page 10*)

The scheme adopted for salving the structure involved not only righting the bin house but the sinking of piers to rock for the support of the workhouse and the bin house.

The railway engineers decided that the uncertain condition of the workhouse demanded that it be given first attention. The efforts of the construction company were therefore concentrated at first on this tall narrow concrete structure. The columns must be underpinned to rock. On account of the height of the structure, its small base and the heavy loads, it was necessary to shore the building before starting operations under the columns. For this purpose twenty small piers were sunk to rock around the outside of the workhouse. These afforded a sure footing for shores to each outside column. The next step was to sink piers to rock directly under each of the twenty-four columns. Generally, the Chicago well method was followed in the construction of the new foundations. Wells five feet in diameter were used. The underpinning operations were carried on with great care, and extraordinary devices such as a two hundred eighty-pound plumb bob suspended from a height of one hundred sixty feet were adopted to detect undesirable movements. In spite of the treacherous subsoil conditions and the hazards involved, the underpinning of the workhouse which had been begun in December, 1913, was completed without mishap in June, 1914.

In February 1914, the Foundation Company, was ordered to proceed with the straightening of the bin house and thus the most spectacular part of the work was begun. The empty structure weighed twenty thousand tons and the problem was to right it and underpin it to rock. For the sake of economy, it was decided not to raise the structure to its original elevation but merely to rotate it into a vertical position around the west or low edge. This would leave the mat in its final position at about thirty-eight feet below the prairie level.

Figure 1 shows the elements of the scheme to right the bin house. First piers were sunk to rock under the low edge. These were to afford a support for the fulcrum on which the structure was to be rotated and later to become part of the permanent foundations. Righting motion was produced by weakening the core of earth under the high side and by a line of pushers along the west side. The sinking of wells for piers was greatly complicated by water which flowed into most of them at the rate of over one thousand gallons per minute. The whole undertaking was made difficult by the congestion under the structure where the work had to be carried on. The contractor was constantly called upon to resort to special devices. When the fourteen piers under the low side were nearing completion, work on the remaining fifty-six piers was started and was continued during the straightening process. Wells for piers were of the Chicago type seven feet in diameter While work was in progress, the railway engineers decided that it would be desirable to have the mat of the structure righted above the ground water level instead of below as it would be at —38. To accomplish this end, the structure was rotated on the fulcrum under the west side through about ten degrees. Then the fulcrum was changed to the next easterly row of piers and the structure rotated through about eight degrees. In this manner, the fulcrum was shifted three times and the bin house actually lifted more than twelve feet. Today in its vertical position it is about fourteen feet below its original position. It was not raised to its original level because it satisfactorily serves its purpose as it is.

The task of righting the bin house was started about March, 1914. It was completed October 17 — within two days of the estimated time. As in the case of the workhouse, precautions were necessary throughout the operation and it was completed without mishap. Measurements to detect movement or dangerous stresses in the structure were taken twice daily. The success of the undertaking depended absolutely upon the fidelity of the engineers. It is in use today — an efficient unit in the Canadian Pacific Railway System and it is worthy of note, that the salvaging operation cost but one-tenth of the estimated cost of wrecking and rebuilding.

Engineers interested in details will find them in the transactions of the American Society of Civil Engineers, Vol. LXXX page 799.

MEETINGS AND CONVENTIONS

April 6. *American Chemical Society.* Gas and fuel section; R. S. McBride, Colorado Building, Washington, D. C. Motor fuel symposium at New Haven, Connecticut.

April 16–18. *American Society of Mechanical Engineers,* 29 West 39th Street, New York City. Pacific Coast Regional Meeting at Los Angeles.

April 18–20. *Society of Industrial Engineers;* George C. Dent, 327 South La Salle Street, Chicago, Illinois. Spring Convention at Cincinnati, Ohio.

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Plumbing Heating and Lighting

HARDWARE, PAINTS AND OILS

BRINGING MORE DAYLIGHT INTO INDUSTRIAL BUILDINGS.

Dr. George M. Price, writing on "The Importance of Light in Factories," in "The Modern Factory," states: "Light is an essential working condition in all industrial establishments, and is also of paramount influence in the preservation of the health of the workers. There is no condition within industrial establishments to which so little attention is given as proper lighting and illumination. Especially is this the case in many of the factories in the United States. A prominent investigator, who had extensive opportunities to make observations of industrial establishments in Europe as well as in America, states: "I have seen so many mills and other works miserably lighted, that bad light is the most conspicuous and general defect of American factory premises."

"My own investigations for the New York State Factory Commission support this view. In these investigations it was found that 36.7% of the laundries inspected, 49.2% of the candy factories, 48.4% of the printing places, 50% of the chemical establishments, were inadequately lighted. There was hardly a trade investigated without finding a large number of inadequately lighted establishments."

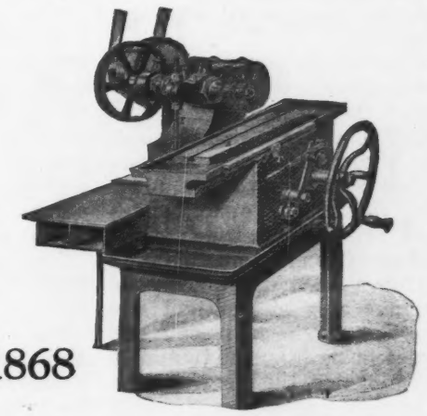
Inadequate and defective lighting of industrial buildings is not confined to the establishments in New York State alone. The same conditions prevail in most sections of the country.

Such conditions as mentioned above are entirely opposed to the laws of health, sanitation and efficiency. Wherever poor lighting conditions prevail, there must be a corresponding loss of efficiency and output both in quality and in quantity. American industry is not using nearly enough daylight and sunlight in its buildings. Every endeavor should be made to use as much as possible of daylight for lighting purposes. To obtain this it is of course necessary that the rays of daylight and sunlight are permitted to enter the interior of the buildings as freely as possible, with the important modification that the direct rays of the sun must be properly diffused to prevent glare and eyestrain. A glass especially made for this purpose is known as Factrolite, and is recommended for the windows of industrial plants. Windows should be kept clean if the maximum amount of daylight is to pass through the glass, but the effort will be well repaid by the benefits secured.

In the presence of poor lighting, we cannot expect men to work with the same enthusiasm as when a well lighted working place has been provided. The physical surroundings have a deep effect upon the sentiments of the employes, and where bad working conditions are allowed to prevail, there is invariably a lessening of morale and satisfaction created thereby. Neglecting to utilize what nature has so bounteously provided, daylight, and which is so essential toward industrial efficiency, we have an instance of wastefulness, but now that the importance of good lighting is becoming recognized, undoubtedly more attention will be given by progressive industrial employers to furnishing the means which are essential for their workers to secure and maintain the efficiency, which counts for so much in the success of any industrial concern in this competitive age.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,
220 Fifth Avenue,
St. Louis. New York, Chicago.



Elbow Grease and the Touch of a Finger

THE plain milling machine of 1868 was a vast improvement over the file and cold chisel as a means of shaping metal. Yet the old machine required husky arms and a strong back to work the hand feed of the table through the long hours of the day.

The Brown & Sharpe Automatic Milling Machine of 1923 starts with the touch of a finger and the table will feed back and forth continuously as long as desired. The spindle will start, stop or reverse automatically and the entire machine is designed for the rapid production of duplicate parts.

In addition to this machine, we build a complete line of milling machines which is listed in our No. 137 Catalog, a copy of which will be sent on request together with special literature on this No. 33 Automatic Milling Machine.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

OFFICE BOY

(*Continued from page 22*)

central station, and forced into the dispatching lines.

For department stores, catalog houses, banks, etc., where the requirements demand continual service and where the conditions make quiet operation preferable, the straight vacuum type system gives the most satisfactory service. Power saving devices can be furnished, which keeps the cost of operation at a minimum.

For factories, etc., where the conditions require only intermittent service and where the slight noise made by the air escaping from the terminals is not objectionable, the one way tube pressure system equipped with automatic power saving device is just as satisfactory and the initial cost somewhat less than for the vacuum type. The cost of operation is low due to the fact that the power unit runs only at minimum speed except when carriers are in transit. Also where pressure tanks are already in use no additional power unit is necessary except the low pressure tank as described above.

The combination vacuum and pressure system can also be very satisfactorily adapted to factories, manufacturing plants, etc., especially where no other air pressure systems are in use. With this system individual vacuum lines can be run into private offices, etc., where absolute quiet operation is demanded.

The next time you make a purchase in a department store, where a tube system is used to make purchase transactions with the cashier's office, probably located on another floor or in another part of the building, count the number of seconds you have to wait for the return of the cash carrier containing your change or charge authorization and you will realize to some extent the important part played by the system in the establishment's attempt to give its customers the instantaneous service demanded by the public today.

STARKWEATHER & BROADHURST, Inc.

Engineers and Contractors
for
Power Plant Apparatus

TELEPHONE CONGRESS 1810 **79 MILK STREET, BOSTON**

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THE WARREN SOAP MANUFACTURING COMPANY

Textile Soaps

77 SUMMER STREET **BOSTON, MASSACHUSETTS**

CHEMICAL LABORATORIES

(*Continued from page 7*)

scale, and afford an unparalleled opportunity for full-scale study which has proved to be invaluable in the development of the more able students.

The Research Laboratory of Applied Chemistry occupies about fourteen rooms, and includes a staff of seventeen workers. It was formally established in 1909 and has performed notable service in its contributions to the industries, both in its scientific output and in the training of men to take positions of the highest responsibility. The following may be cited as typical of the investigations now in progress: (1) Mechanism of Lubrication, (2) Methods of Refining Oils, (3) Development of Anti-Knock Materials, (4) Corrosion of Steels, (5) Rubber Compounds and Compounding, (6) Testing of Tire Cords. The work of this and the other research laboratories will be treated in a later article in this series.

The Departments maintain extensive stocks of apparatus and chemicals, equivalent in scope and quantity to those of large commercial dealers in chemicals and supplies. These supply rooms are operated by the Division of Supplies of the Institute from which the Departments purchase stock as needed. The turn-over of material amounts to about $40,000 annually.

Each Department maintains a central depository of loan apparatus for thesis or other research work, and the collections of chemicals, both organic and inorganic, are extensive and valuable and the scope of these collections is extended yearly.

Liquefaction of Helium Gas. Liquefaction of helium gas was accomplished by Professor John C. McLennan of the Toronto University a short while ago. It is the first time the fact has been performed outside Holland. This achievement will play an important part in the refrigerating problem. It will also aid in the development of airships because helium is a non-inflammable gas possessing 92 per cent of the lifting power of hydrogen.

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Made of extra quality cotton yarn, carefully inspected and guaranteed free from all imperfections of braid or finish. The colored spots are our trade-mark, used only with this quality.
We make braided cord of all sizes, kinds and colors, for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes.

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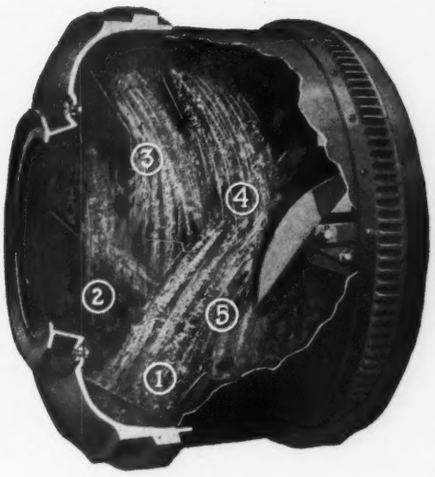
Why does Koehring Five Action Mixing Principle give Plastic Concrete?



(1) Blade cuts through materials with churning action. (2) Blade carries materials up, spilling down again against motion of drum. (3) Materials hurled across diameter of drum. (4) Materials elevated to drum top and cascaded down to reversed discharge chute which (5) with scattering, spraying action, showers materials back to charging side for repeated trips through mixing process.

TESTS made at Purdue University by Professor W. K. Hatt prove that plasticity of concrete depends on the proper mixing. To obtain this plasticity in the minimum time, the individual particles of cement, sand and stone must be so mixed that they will find their proper position in the concrete. Then the cement acts as a lubricant and the concrete will be plastic and easy to work, instead of harsh and difficult to place.

The Koehring Five-action Re-mixing Principle prevents separation of aggregate according to size—coats every particle of aggregate thoroughly with cement—and delivers plastic uniform concrete to the last shovelful of every batch.

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CAMBRIDGE, MASS.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY offers courses, each of four years' duration, in Civil, Mechanical and Electrical Engineering; Naval Architecture and Marine Engineering; Mining Engineering and Metallurgy, and Geology and Geological Engineering; Architecture and Architectural Engineering; Chemistry, Chemical Engineering and Electrochemical Engineering; Biology and Public Health, and Sanitary Engineering; Physics, General Science and General Engineering; and in Engineering Administration. These courses lead to the Degree of Bachelor of Science.

To be admitted to the first year class, applicants must have attained the age of seventeen years, and must satisfactorily fulfill entrance requirements in Algebra, Plane and Solid Geometry, Trigonometry, Physics, Chemistry, English, History, and French or German and one elective subject. Examinations are required in all subjects except Chemistry, History and the elective, the requirements for which are fulfilled by the presentation of satisfactory certificates. A division of these entrance subjects between different examination periods is permitted.

Entrance examinations are held at the Institute in September. In June, applicants will be examined by the College Entrance Examination Board in Boston, New York, Philadelphia, Chicago, and many other cities in America and Europe. A circular stating times and places is issued in advance by the College Board.

Graduates of colleges and scientific schools of collegiate grade, and in general all applicants presenting satisfactory certificates showing work done at another college corresponding to at least one year's work at the Institute, are admitted, without examination, to such advanced standing as is warranted by their previous training.

Graduate courses leading to the degrees of Master of Science, Master in Architecture, Doctor of Philosophy and Doctor of Science are also offered. Special Research Laboratories of Physical Chemistry, Applied Chemistry and Science have been established.

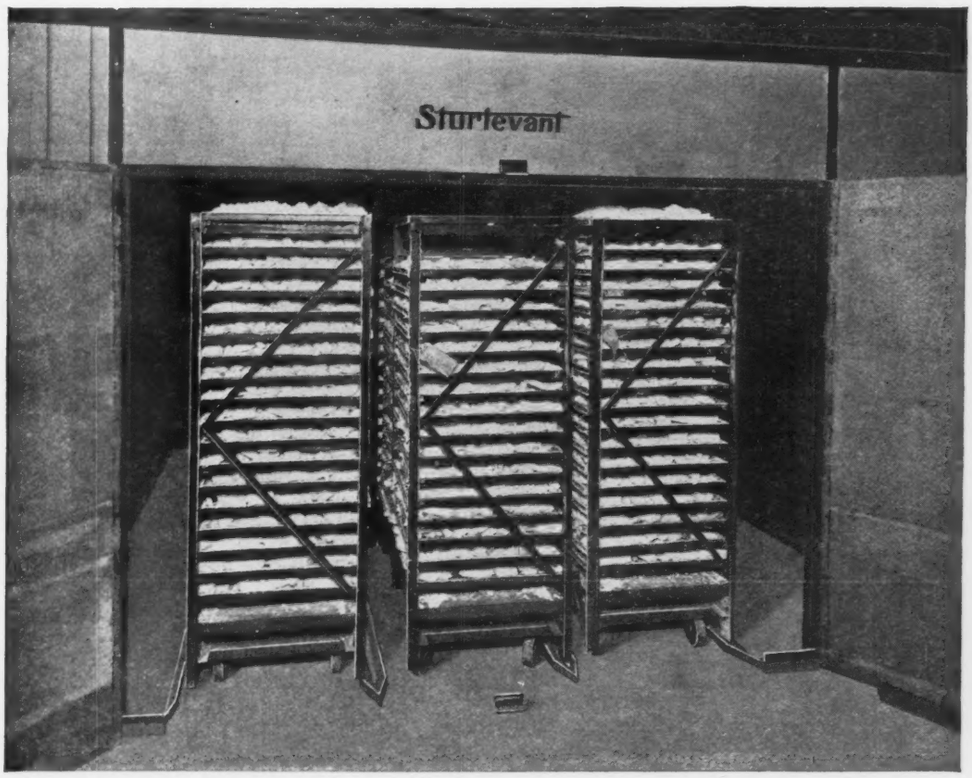
PUBLICATIONS

Bulletins of General Information, Courses of Study, Summer Session, Advanced Study and Research; and the Report of the President and the Treasurer.

Any of the above-named publications will be mailed free on application.

For information, address

ADMISSIONS OFFICE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE 39, Mass.



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Each dryer is designed and built to meet the requirements of each individual product and plant

THE type of dryer required by the manufacturer is entirely dependent on his product and the particulars of manufacturing in his plant.

The effective and economical air supply system, the method of circulation and the most suitable type of fan and heater determine the Sturtevant Drying System recommended.

Sturtevant Dryers are so constructed that a positive circulation of air insures proper distribution and equal air velocities throughout the dryer, enabling all the material to be dried uniformly.

The maximum vapor capacity of the air is utilized by regulating the volume of air re-circulated, the fresh air admitted to the dryer and the moisture-laden air expelled. Automatic temperature and humidity control systems are furnished with dryers wherever advisable.

The resultant system insures the highest drying efficiency, requiring the minimum of power consumption, consistent with the material to be dried.

Sturtevant

(REG·U·S·PAT·OFF·)

Hyde Park, Boston, Mass.

VOLTA EXPLAINING HIS BATTERY TO NAPOLEON

How Electrical Engineering began

IT IS not enough to experiment and to observe in scientific research. There must also be interpretation. Take the cases of Galvani and Volta.

One day in 1786 Galvani touched with his metal instruments the nerves of a frog's amputated hind legs. The legs twitched in a very life-like way. Even when the frog's legs were hung from an iron railing by copper hooks, the phenomenon persisted. Galvani knew that he was dealing with electricity but concluded that the frog's legs had in some way generated the current.

Then came Volta, a contemporary, who said in effect: "Your interpretation is wrong. Two different metals in contact with a moist nerve set up currents of electricity. I will prove it without the aid of frog's legs."

Volta piled disks of different metals one on top of another and separated the disks with moist pieces of cloth. Thus he generated a steady current. This was the "Voltaic pile"—the first battery, the first generator of electricity.

Both Galvani and Volta were careful experimenters, but Volta's correct interpretation of effects gave us electrical engineering.

Napoleon was the outstanding figure in the days of Galvani and Volta. He too possessed an active interest in science but only as an aid to Napoleon. He little imagined on examining Volta's crude battery that its effect on later civilization would be fully as profound as that of his own dynamic personality.

The effects of the work of Galvani and Volta may be traced through a hundred years of electrical development even to the latest discoveries made in the Research Laboratories of the General Electric Company.

General Electric Company

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